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The Doings Of Expanded Metal

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1024 Ridge Avenue, Philadelphia, Pa.

The Expanded Metal System of

Steel-Concrete Construction

for

Foundations, Piers, Sewers, Bridges, Subways, Reservoirs, Flumes, Tunnels, Conduits, Vaults, Tanks, Cisterns, Septic Tanks, Storage Bins, Dry Kilns, Coal Bunkers, Dry-Docks, Fortifications, Retaining Walls, Power Plants, Warehouses, Naval Storehouses, Factories, Sidewalks, Deck Houses, Floors, Roofs, Domes, Etc.

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Expanded Metal

EXPANDED METAL is a unique material in the mechanical world. It was designed and invented with a view to a special purpose, to which it has been put to a very large extent, but it nevertheless found a very new and unexpected purpose and place of usefulness wherein it has achieved still greater distinction. Though apparently simple in the possibility of its manufacture, it has nevertheless required great skill to bring it to a point of commercial perfection. It is nothing more or less than plain sheets of steel, slit in regular lines and opened into meshes of any desired size or section of strand. The operations of shearing the steel and opening the meshes are simultaneous and are performed when cold. No material is wasted, and there are no pieces cut out. It was originally termed by the inventor "slashed metallic screening," and was intended as a material for fencing, window guards, etc. It is probable to-day that less than one per cent. of the output is used for the originally intended purpose, the greater part of it now being used in the directions indicated in this volume. The finished sheets of the material are from three to eight times as large as the original sheet of steel, according to the size of mesh, and they are produced with a uniform length of 8 feet, the width ranging according to requirement from 12 inches to 6 feet. The material is cut from steel, as light as 27 gauge, with meshes 3/8 inch, in which form it is used for lathing, and from that size to sheets cut from No. 4 gauge steel, with diamond meshes 5 x 12 inches, with many intervening sizes and widths.

There are in this country five large factories operating to their full capacity, besides seven other companies devoted to the sale and construction of the material in various forms. There are also half a dozen or more companies on the continent of Europe, besides one in Australia. It is probable that in this country alone the output for the present year will amount to more than 20,000,000 square feet of the various kinds produced.

Expanded Metal—Concrete

THE growth and development of two individual industries have resulted in the production of what might be called a new industry. Expanded metal for many years occupied a large field in the building world before it found its place in connection with concrete. Cement alone had been a standard material before the accomplishment of this desirable combination. The following pages illustrate and describe to what varied uses this admirable combination of two materials has been put. While it would seem that every feature of building and engineering operations has been attempted successfully, it is to be acknowledged that still new uses for the combination are appearing from day to day. It is also true that as the science is being practiced greater economies are being wrought out. In the succeeding pages no attempt will be made to treat of the various subjects from other than a purely practical standpoint. In other words, we shall only attempt to point out what is being accomplished, with very little to say in answer to the scientific " why " and " how." We shall consider it sufficient to point out what has been done, and to note, generally speaking, the efficiency with which the results, in each case, have been accomplished.

The A B C of the Subject

The introduction of steel as a member of a slab or beam of concrete has its warrant in the fact that the construction without a tension member can be used in only a limited number of cases, where economy in weight and cost do not enter as controlling factors. The design of slabs or beams of concrete having the same span and to carry the same applied load, one with and one without the steel member, when taken as a problem for investigation presents just such a case as will show not only the economy of the introduction of the metal, but as well the possibility of use of the reinforced, as against the impossibility of use of the unreinforced slab. While there is a wide range in the results of investigations of different engineers who have made this problem a study, due to the different assumptions made by each as regards the action of concrete under extreme stresses, there is still the conformity of results which proves that for the usual spans as represented by Figures Nos. 1 and 2, and spans ranging from 4 to 8 feet, there is a saving from three to four hundred per cent. in depth. This means an equal saving in weight to develop the same strength. All also agree that the actions with and without the metal differ in that the slab which is reinforced is elastic while the other is brittle. These characteristics, all other considerations being put aside, make a beam either safe or unsafe, according to whether the metal is used or not, if we consider that a warning of final rupture under load is an index to safety. The reinforced beam bends appreciably before breaking, while the unreinforced one breaks before bending appreciably. Therefore, knowing as we do that all the steel must be broken by tension developed at the bottom chord, and knowing the strain developed here, and the tensile value of the steel inserted, we have a certain construction with, as against an uncertain one without, the introduction of the steel tension member.

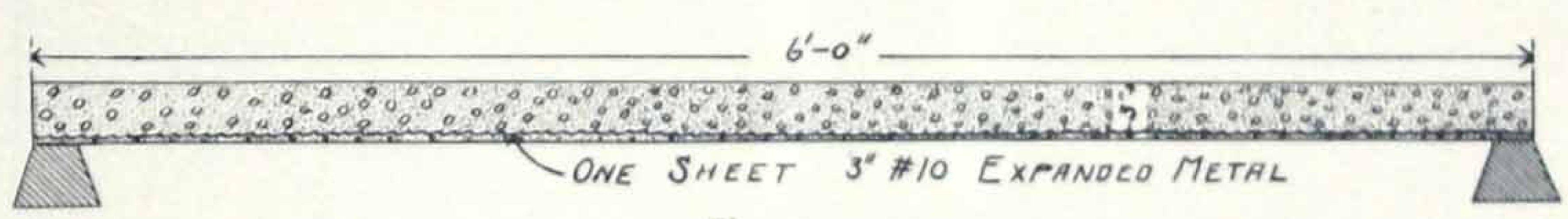


Fig. 1

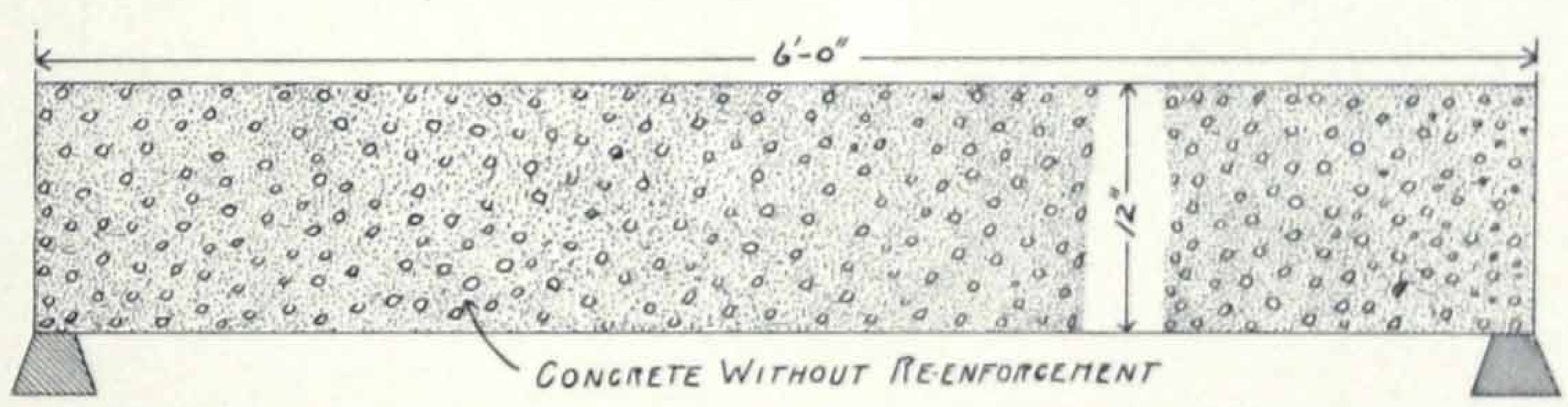


Fig. 2

Hence we conclude that the three prevailing factors in the case, viz., possibility of construction, economy of construction and safety of construction, all demand that we reinforce our concrete beam with its tension member of steel.

The accompanying Figures 1 and 2 are designed to illustrate the consensus of opinions of four engineers, who have given this problem a study. Being men of unquestioned standing, who have had years of experience designing and building structures where concrete has been largely used, it shows conclusively the value of the contentions we

are making in favor of the introduction of the steel as a vital factor in the construction of various structures of concrete. Steel and concrete when used rightly together are bound to find ready recognition in the building world. Figure 1 shows a slab 3 inches thick, reinforced with a layer of 3-inch No. 10 expanded metal, and Figure 2, one 12 inches thick of concrete only. Between these two thicknesses is the economic limit for the majority of cases.

We desire to emphasize one point more, viz., there is no form in which a given amount of steel, in weight per square foot, can be better deployed in the slab than in the material referred to. Expanded metal is, notwithstanding its mesh form, nevertheless still a solid sheet, and in its use every portion of the slab has its reinforcement, and it is all in the right place.

When the construction of expanded metal floors was first attempted in this country, the maximum span based upon either safety or economy was supposed to be limited to 5 feet on iron beams or other means of support. Gradually this was lengthened out from 5 to 8 feet, and the still more venturesome engineer soon accomplished 10 foot spans. The next jump was to 15 feet and then to 20 feet. We have recently published illustrations of work being done at the latter figures. Reference is made in this edition to recent factory construction. Just where the limit of economy is on long span construction is a subject upon which engineers differ. It is safe to make one assertion, that long span construction is possible so far as carrying capacity of the structure is concerned. The methods employed by different engineers and different contractors vary, but all these varying methods have their degrees of merit, and it is enough to say that based upon the combination of expanded metal and concrete, it is possible to meet any demand made by good practical engineering.

Lathing

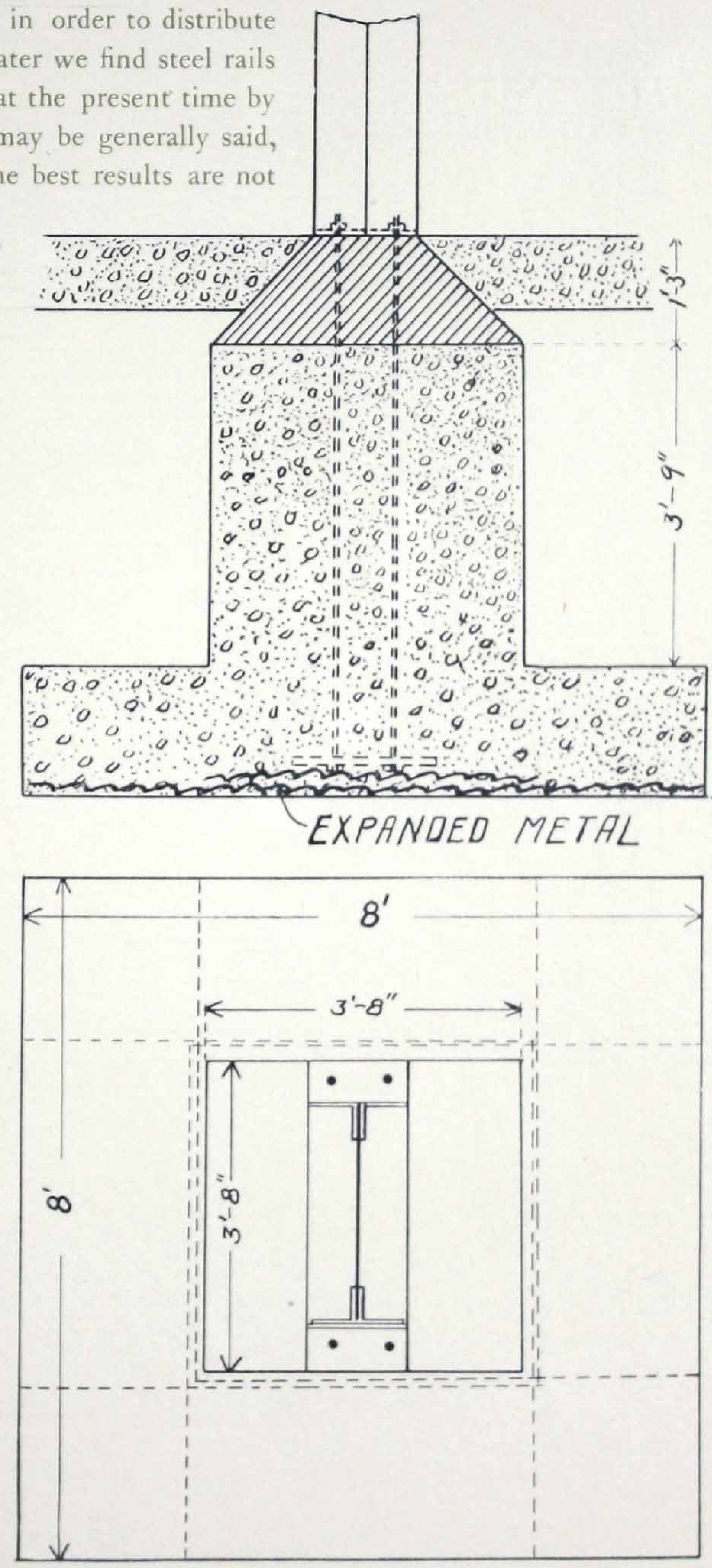
While the majority of these pages are devoted to the uses of expanded metal, especially with reference to its connection with concrete construction, it should not be forgotten that demand for our material as a lathing is still on the increase. From sales amounting to but a few thousand yards annually when the business was first begun, it is now counted by millions of yards. The material is specified, as stated, in all government work throughout this country and is used almost exclusively by first-class architects for lathing purposes. Improved machinery has enabled its more economic production and the additional benefits of metal lathing in house construction are being better understood from year to year. This is true to such an extent that very few first-class buildings are erected in the cities of the country wherein metal lath is not used.

Coal Shaft Lining

One of the unique uses to which expanded metal has recently been put is in the lining of a coal shaft. This was accomplished by Mr. Geo. Hill, C. E., in the No. 2 shaft of the Manville mine at Scranton, Pa. The shaft was about 60 feet in depth, and was an exceedingly difficult one to keep in proper condition. It had been lined with a double wood cribbing with clay between the cribs. Quick sand and superfluous water rotted the wood of the cribs out, and it was determined to line it with reinforced concrete. This has been successfully accomplished by substituting in the place of the cribs a slab of concrete and expanded metal 18 inches thick, which it was found could be done at less expense than the lining of wood, aside from the fact that the work was permanent and will not require frequent repairs as formerly.

In Foundations

FOUNDATION practice, along with all of the other parts of building construction, has been undergoing a great deal of desirable change, due to the better knowledge of the performance of various materials and the severe competition obtaining between structures of the same class to secure remunerative returns. Very early in the erection of structures broad footings of timber cribwork were employed in order to distribute the loads over a large area of low-carrying capacity soil. Later we find steel rails used for this purpose, which practice has been improved on at the present time by the introduction of steel beams of moderate section. It may be generally said, however, that the practice is still far from perfect and that the best results are not obtained for the metal employed. This is particularly so with one familiar with the use of steel and concrete in combination, who sees the ordinary cribwork installation and is aware of the fact that the concrete in itself possesses the necessary compressive strength and only requires the addition of the proper amount of steel to increase its tensile strength to the desired point. The well-known value of expanded metal for this purpose and the writer's predilection of steel and concrete have led him to make several designs for footing courses in a soft soil, showing a material saving over the ordinary practice. One case was that of a seven-story apartment building to be erected on made ground where the fill averaged thirty feet in depth. The proposals for the excavation, sheet piling and the building of stone foundation walls on solid bottom were from $18,000 upwards. Spread course footings of expanded metal, the expanded metal laid with its long axis at right angles to the wall, were designed, reducing the pressure on the soil to 1,500 pounds per square foot. The cost of installation was less than $7,000, a clear saving of over $11,000. In the works executed for the Dunmore Iron & Steel Company the engine room had to be built on a culm bank which was compressible and subject to continual settlement. There was heavy concentration of load due to the position of engines and generators. The basement was built in the form of a box, with 12-inch bottom forming the basement floor, 12-inch top forming the first floor and 12-inch side walls with courses of expanded metal in the top and bottom surfaces. The result in the equalization of the load and its distribution over the entire building was satisfactory. In the shops of the Central Railroad Company of New Jersey, spread footing courses 9 feet square were necessary. It was undesirable to make the excavation as deep as would have been necessary to secure the proper slope for the concrete, and the footing courses were consequently made 2 feet thick with expanded metal in the bottom. In the design of spread footings for buildings in New York the same principle can be employed and is susceptible of a very much greater extension, deep sections of I-beams being used as primary members with expanded metal between, properly disposed to secure the distribution of the load. In this way the concrete is advanced from its position as simply a filling and protection to the beam to one where it can do useful work.

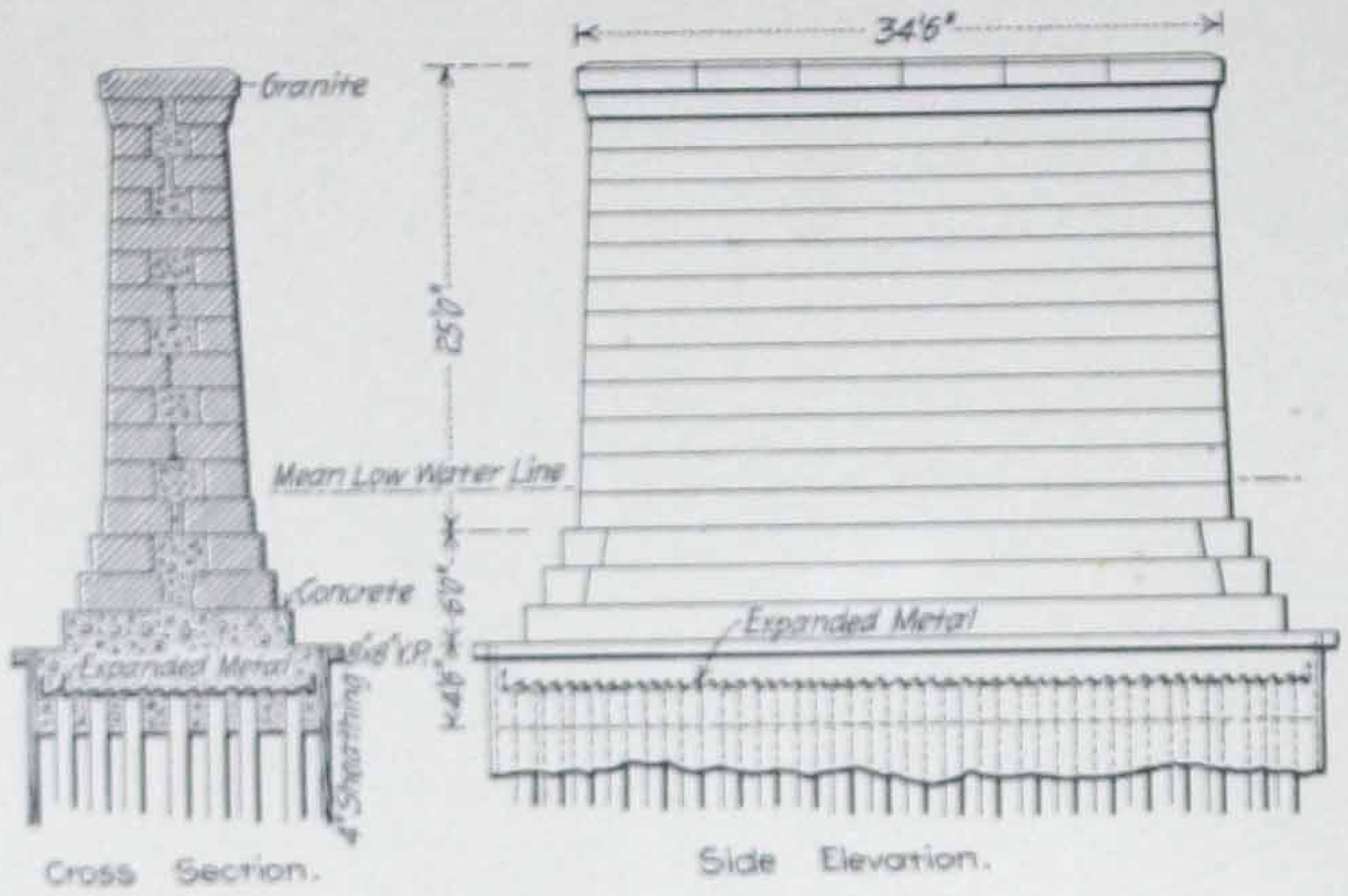


Expanded Metal as Used in Foundations

Piers

THE principle involved in the combination of steel and concrete has no more desirable use than that in pier building. In the case which we have for illustration the work was done some years ago in Philadelphia, and the complete success of that development has warranted other similar instances in more recent years.

In the reconstruction of the Penrose Ferry bridge across the Schuylkill River, the new piers were made much larger than the old ones. The increased size of the footings made it necessary to drive a number of new piles beside the old ones, and it seemed probable that unequal settlement would take place. The old piles are 12 inches and the new ones 14 inches in diameter, and it was decided by the Department of Public Works to use a steel binder, tying the concrete together to prevent cracking in case the piles should settle unequally. Investigation soon showed that expanded metal was by all odds the best material for this purpose, and 6-inch mesh, cut from No. 4 steel, was specified. The work was completed months ago, and 5,000 square feet was used in the various piers and approaches. The sheets of expanded metal have a lap of 6 inches at all intersections, and are secured to the tops of the piles with extra heavy staples. Through the courtesy of Mr. C. A. Trix, Superintendent of Bridges, and Mr. Harrison, C. E., Assistant Superintendent of Bridges, under whose immediate care the plans were drawn, we are able to present some of the details of construction of Pier No. 11, which is typical of that used throughout.



Bridge Pier, Penrose Avenue, Philadelphia, Pa.

Expanded Metal in Exposition Buildings

In the Columbian Exposition in Chicago, in 1893, expanded metal figured quite largely, and oddly enough a very large portion of it used in these buildings was visible to the eye of the visitor. It was in the days when expanded metal was known as fencing material primarily, and hence miles of railings around the galleries of the main buildings were built of wood frames to which were attached sheets of expanded metal. A small amount of it was used as a lathing in the buildings of a more permanent character, in which case, of course, it was hidden.

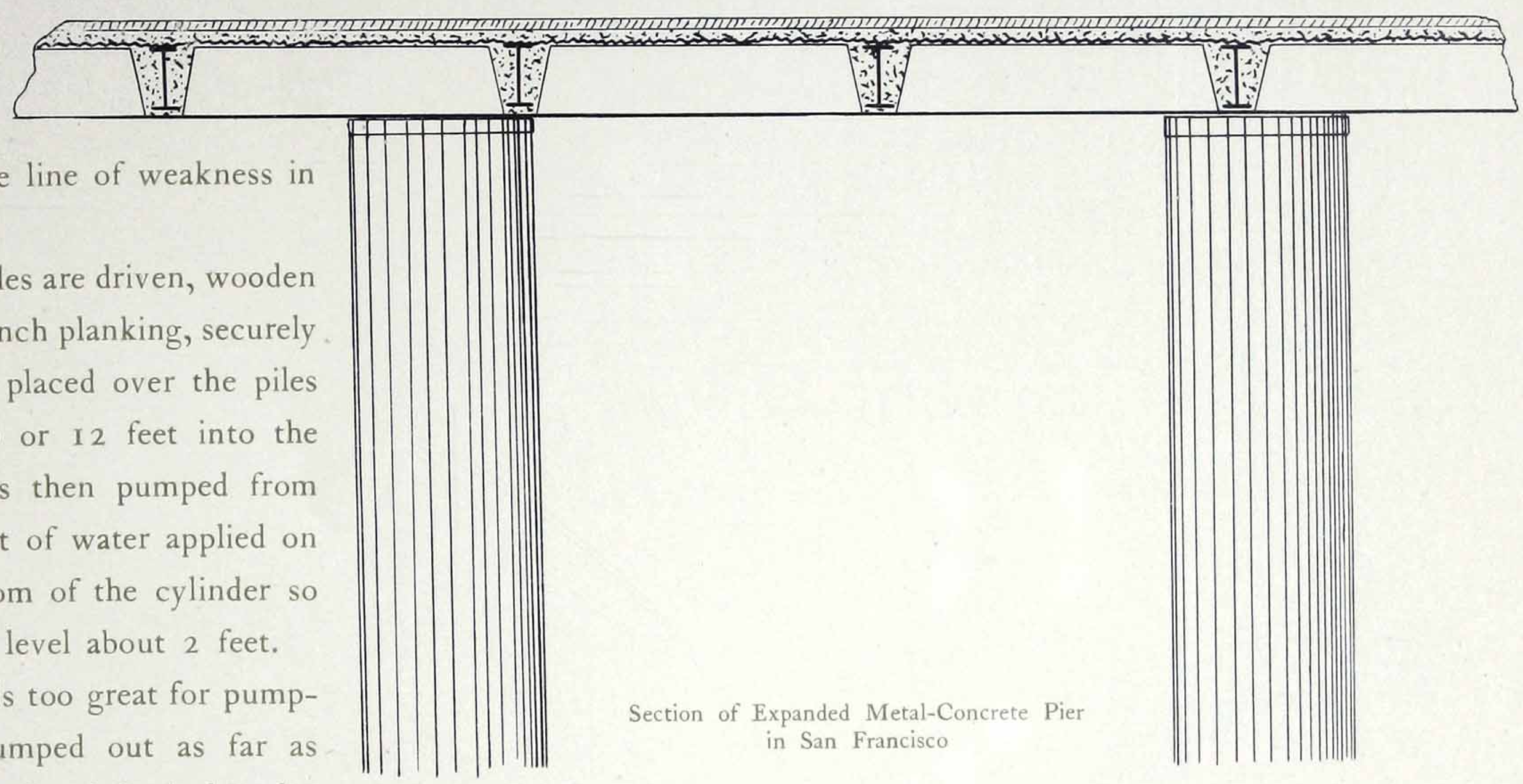
In the Paris Exposition of 1900 there was used more than 1,000,000 square yards of our material, and probably all but a few thousand yards of it was hidden in the walls, floors and roofs of the buildings, so that nothing short of a crowbar would have enabled the visitor to find it. It is true that more or less of it was used in railings in certain portions of the buildings. A large quantity of it was used in the construction of concrete bridges which crossed the River Seine.

In the Buffalo Exposition the same facts occur as in Paris. Many thousands of yards of material were used, but practically all is hidden. Scattered throughout the grounds at Buffalo are scores of small fanciful pagodas and public park seats. In the erection of these and very similar structures expanded metal is used as the bonding material for concrete work, and by the use of the joint materials very ornamental and effective results have been secured.

Wooden Cylinder Pier

ONE of the many uses to which expanded metal has been put is illustrated by the accompanying cuts, showing the cylinder pier as used by Mr. Howard C. Holmes, the engineer of the State Harbor Commissioners, San Francisco, who is also the inventor of this pier.

The piers are intended as protection against terredos, and the piles are calculated to take all loads. Three piles are first driven in clusters to such depths as required and the heads are sawed off, one about 2 feet from the top, another 6 feet from the top, another 8 feet from the top. This is to prevent the line of weakness in the concrete.



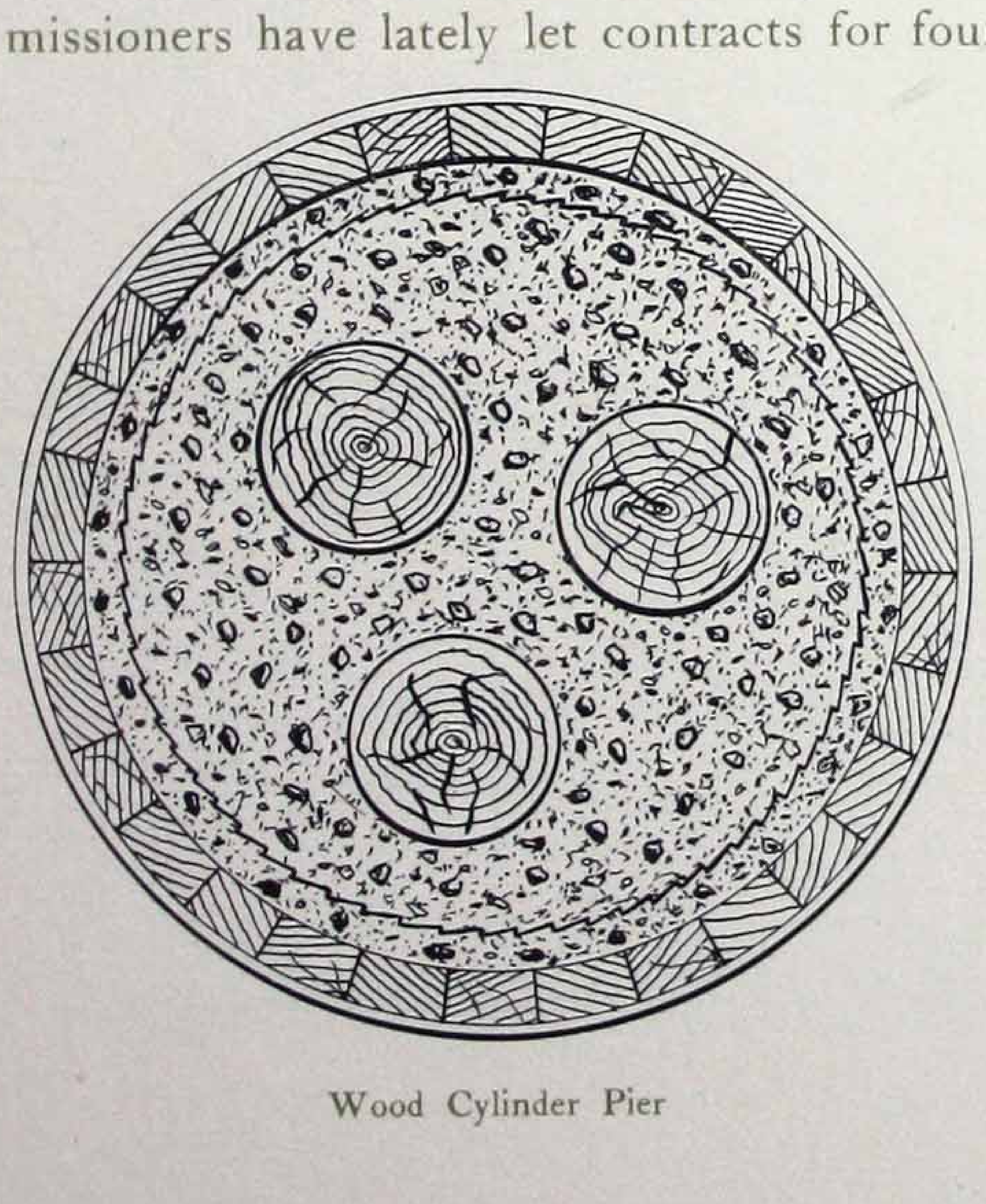
Section of Expanded Metal-Concrete Pier in San Francisco

After these piles are driven, wooden cylinders made of 3-inch planking, securely hooped together, are placed over the piles and driven about 10 or 12 feet into the mud. The water is then pumped from the inside and the jet of water applied on the mud in the bottom of the cylinder so as to make the mud level about 2 feet.

If the depth is too great for pumping, the water is pumped out as far as possible and concrete placed dry in loosely-woven sacks is dropped into the water, and the cement to fill the cylinder is mixed in the usual manner and placed in the cylinder. Before the concreting is done, however, cylinders of No. 16 gauge expanded metal are placed inside of the wooden cylinders with a space of 3 inches between the expanded metal and the wood, which allows for tamping.

The calculation is that in time the terredos will make away with the wooden cylinders, thus leaving the piles fully protected by the concrete, which in turn is reinforced by expanded metal, which also prevents cracking.

This mode of construction has met with a great deal of favor in San Francisco harbor. The harbor commissioners have lately let contracts for four of these wharfs, which call for 200,000 square feet of expanded metal.

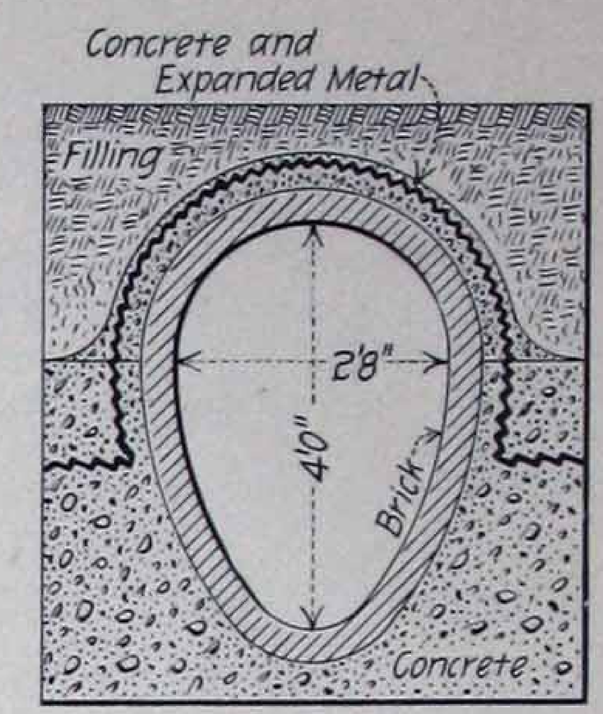


Wood Cylinder Pier

Our illustration shows a section of the wooden pier itself, also a cross section from a small area of the general pier. As will be seen, the dock floor consists of a system of steel framing with a system of expanded metal floors covering the entire area.

Contracts have been recently let for the reconstruction of a pier at San Juan, Porto Rico, belonging to the New York and Porto Rico Steamship Company. The pier formerly rested on wood piling and was destroyed by fire practically to the water line, within six months. These piles are to be sawed off to a level and upon them placed cast-iron caps. To this will be bolted a system of steel framing, and over the entire area of the pier, covering something over 40,000 square feet, will be erected an expanded metal-concrete floor slab with a granolithic wearing surface. The pier will be protected by double lines of fender piles.

In Sewers

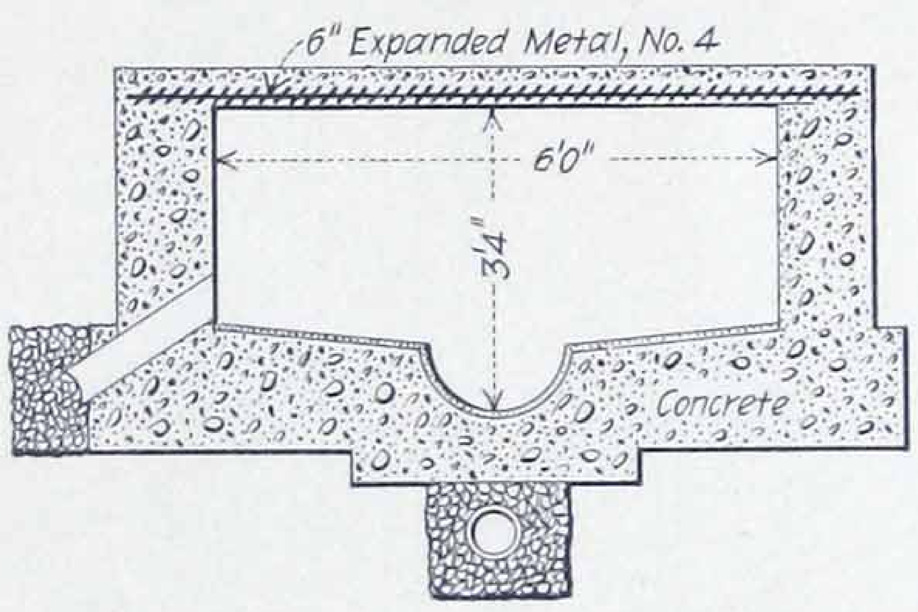


Sewer Section in Boston

THE use of our material in sewer construction has been in the progress of development for several years and has now become quite general throughout the country. We illustrate in this connection a few sections showing the best method of use under varying conditions.

In Boston

Some four or five years ago a difficulty was met with in the building of a large sewer in Neponset Valley, in Boston, at a location where it was not possible to secure sufficient room for earth filling on top of sewer without going above grade line. This lack of filling resulted in a continued bursting of the sewer by water pressure. The section in question ran through private property and the owner would not permit the extra fill to weigh down the original sewer construction. The chief engineer of the Metropolitan Sewerage Commission, Mr. William M. Brown, after careful examination of the subject of expanded metal and concrete was induced to make a trial by reinforcing a conduit cover for this sewer. After it had been in use for several years he wrote a letter to the Eastern Expanded Metal Co., stating that the work had been done with comparatively slight expense, and that the arch of the sewer had proven abundantly strong and safe to resist the pressure which had resulted in the destruction of previous arches. In other parts of Boston similar difficulties were met with and overcome by the adoption of the same methods and with the same satisfactory results.



Sewer Section in New Jersey

A Sewer in New Jersey

Mr. Lemuel Lozier, an engineer in charge of public work in Hackensack, N. J., solved the difficulty of securing a permanent roofing for a wide, shallow sewer in that city, by the adoption of expanded metal and concrete, as shown in accompanying sketch. The location of the sewer made it necessary, in order to carry the volume of water required, to make it very wide and shallow. The sewer had but one foot fall in its total length of 800 feet. The accompanying sketch shows the details.

In Utica, New York

In Fig. 3 we show a cross section of a concrete arch culvert constructed over a small creek in Utica, N. Y., under plans designed by City Engineer Sam'l Lewis Schultze. The value of the reinforcement in this case, as in many others, was a saving in the volume of concrete and also in the extra height that would otherwise have been necessary.

In Buffalo

In the city of Buffalo a section of the old Hamburg canal was abandoned for its purpose as a canal and changed into use as a sewer. It was originally the property of the State of New York, but the city took it off their hands and decided to make of it a trunk sewer. It was something over a mile in length, and after the erection of masonry side walls it was necessary to make the roof covering of the least dimensions possible, such construction to be permanent. The sewer was 16 feet wide between walls and 13 feet deep below the roof covering. 20-inch steel beams were placed across the opening on 4-feet centres, and between these beams a system of concrete and expanded metal was placed as indicated by accompanying sketch. The original intention was to have the arch between the beams of brick masonry, but the city adopted reinforced concrete as the better and more economic material.

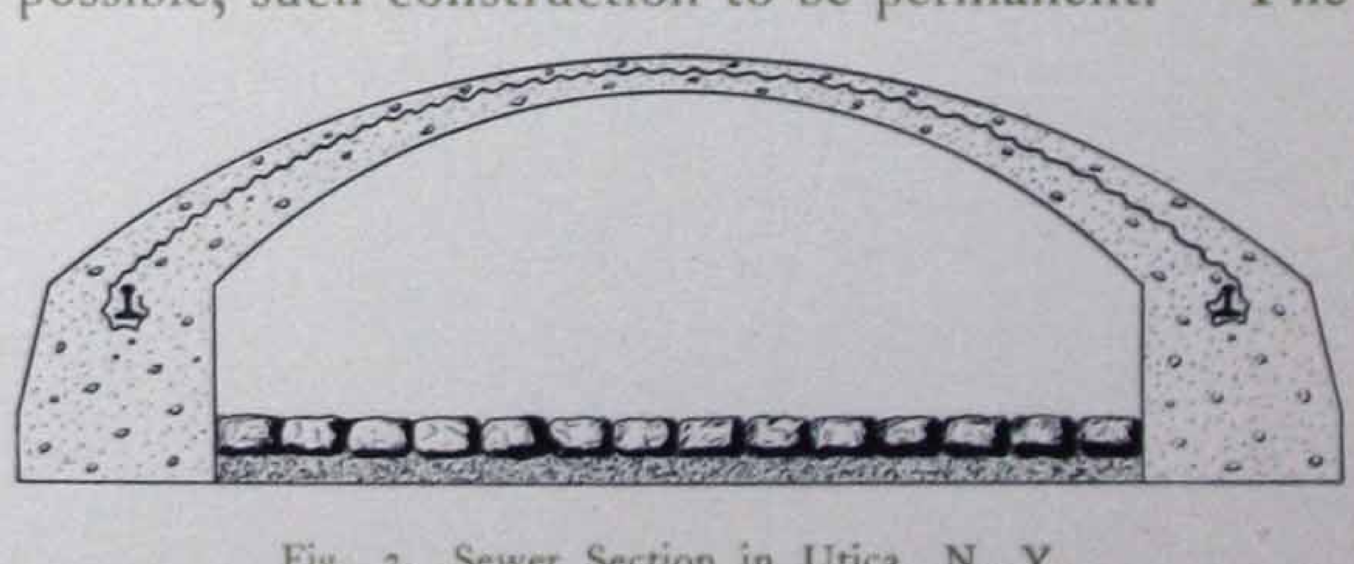
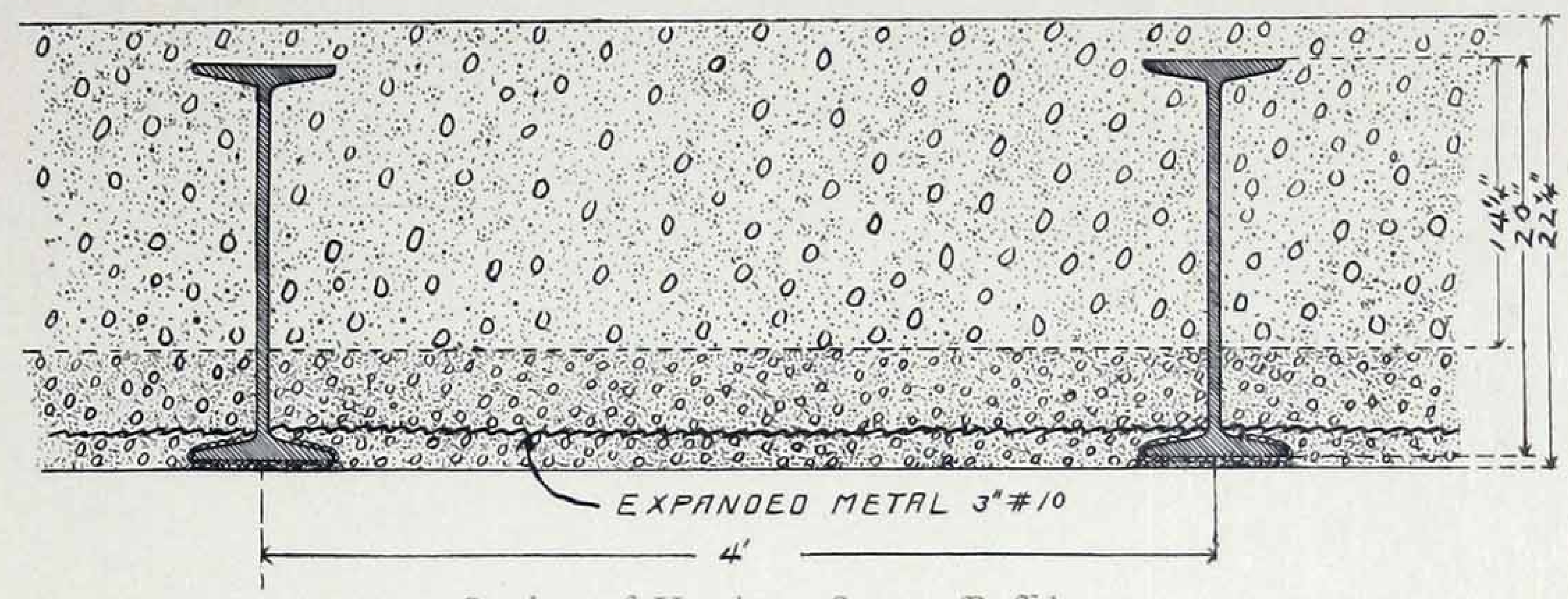


Fig. 3. Sewer Section in Utica, N. Y.

In Brooklyn, N. Y.

In the city of Brooklyn, whose Department of Sewers is in charge of James Kane, Commissioner of Sewers, and Henry R. Assarson, Chief Engineer, a somewhat unusual problem in sewer construction was recently offered. An ordinary 15-foot diameter brick sewer was being erected, and being brought within a short distance of its final outlet in New York Bay. It was found necessary to build several hundred feet of it on an especially constructed pier, in order to be free of the mud and empty into tide water. A portion of the distance referred to was through the middle of a street, so that it was impossible to build it of the original diameter. It was, therefore, necessary in some manner to flatten out the sewer, and accordingly a design was made for the erection of a pile pier wide enough to carry a triplicate section. This was accomplished in the manner quite clearly shown in the accompanying illustration. Piles were driven into the earth and mud of the bay, which are then imbedded in rip-rap and sand, and upon a wooden dock flooring the sewer is built in the manner indicated.



Section of Hamburg Sewer, Buffalo

The sewer sections proper are being erected of brick, and the whole is then enclosed in a concrete mass which is reinforced and tied together with expanded metal, 6-inch mesh No. 4 steel, as indicated in the diagram.

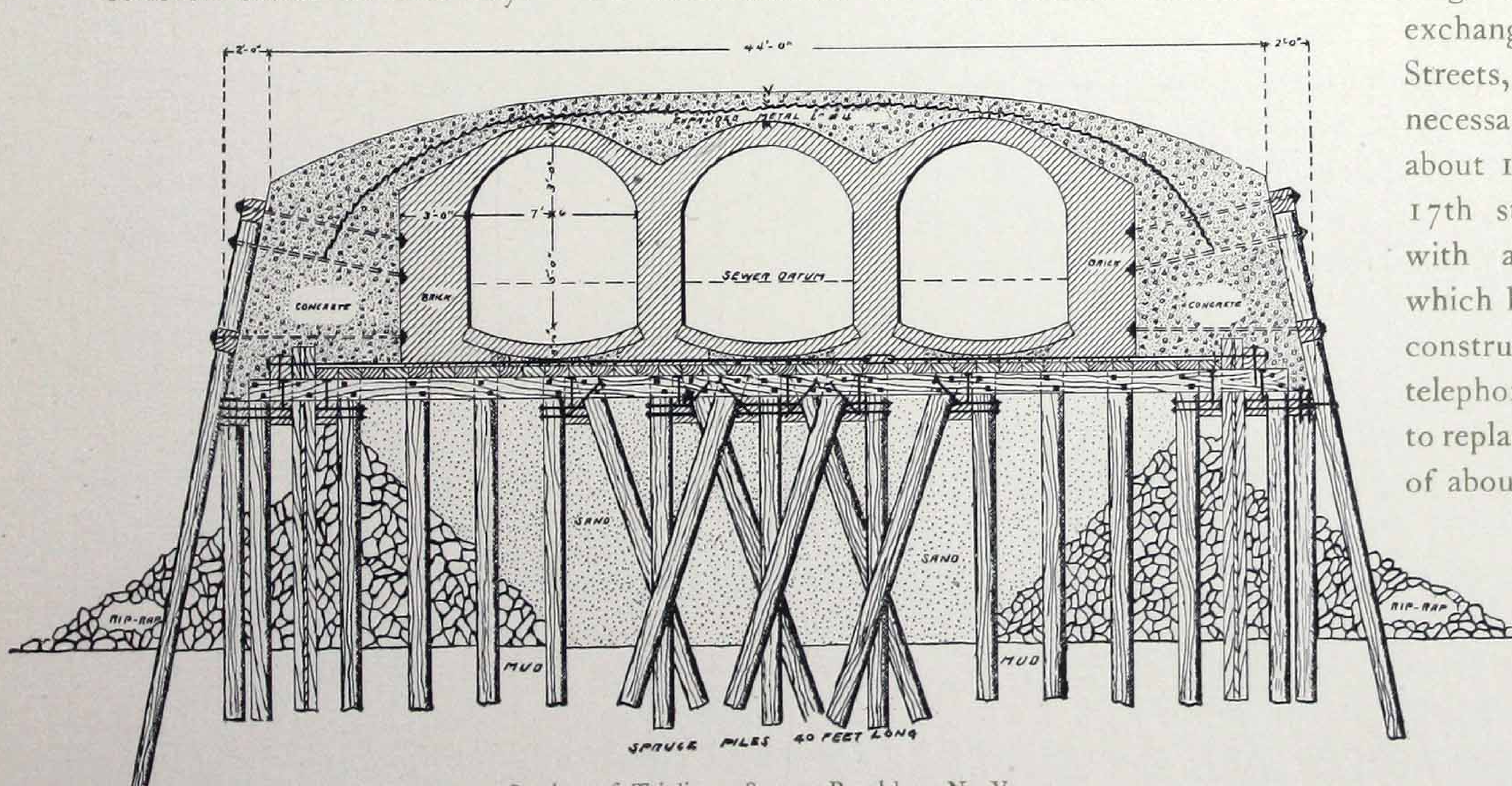
In New Orleans

There have recently been let some very large contracts, amounting to more than $1,000,000, for the reconstruction of a new drainage system in New Orleans. In that city the highest point of land to be drained is only a few feet above average high water. There being little fall available, the gravity system could not be made to work, and hence there was adopted a system of canals of large cross section with slight fall, with pumping stations at occasional points along the line to lift the drainage up to the high end of the next section. In this manner the drainage was carried out finally to Lake Ponchartrain and through Lake Borne to the Mississippi.

The roof covers for all of these drainage canal sections will be constructed of concrete reinforced by expanded metal. It will require many months in building, and several hundred thousand feet of material will be used.

A Philadelphia Sewer

The Bell Telephone Company of Philadelphia recently completed a section of what is believed to be the first concrete sewer in that city. To accommodate the connections between their underground ducts and the new exchange at 17th and Filbert Streets, the company found it necessary to build a manhole about 12 feet by 20 feet under 17th street. This interfered with an old 36-inch sewer which had been of such flimsy construction originally that the telephone company were obliged to replace it entirely for a length of about 50 feet. As the bottom of their manhole was 1 foot below the bottom of the sewer they were naturally anxious to have the latter perfectly tight, and they decided to



Section of Triplicate Sewer, Brooklyn, N. Y.

use a concrete sewer, lined with cement and reinforced with expanded metal. The whole had to be substantially done, as the wall forming one side of the manhole rested nearly on the crown of the sewer, and this wall had to be able to support the pavement of the street above. It was desirable to keep the sides and top of the sewer as thin as possible to avoid interference with the ducts.

An instance where the circular form of sewer was not feasible occurred a year or two ago in Worcester, Mass. This sewer was 7 feet in diameter in section, but in a certain portion of it it was necessary to reduce this depth to 3 feet, which was accordingly widened out to nearly 10 feet, and over it a flat roof of concrete and expanded metal was built under the supervision of Mr. Harrison P. Eddy, Superintendent of Sewers of that city.

Notes

Material is now being shipped to Port Limon, Costa Rica, for the erection of five large warehouses for the use of the United Fruit Company. These buildings when completed will cover an aggregate area of about 20 acres of ground. They will be constructed entirely of steel, with cement floors, outside walls and roofs, and throughout this work in the concrete employed in the various parts of the building expanded metal will be used as the bonding member. This will require many thousands of square feet of material, and the same is being furnished by the Southern Expanded Metal Company, Washington, D. C., and the contracts for the buildings are in the hands of the Structural Iron and Steel Company, Baltimore, Md.

In the construction of the Rapid Transit subways in New York large quantities of expanded metal of the largest mesh have been used for the reinforcement of concrete in what might be termed special methods. One of the uses is in connection with openings in the side walls of the subways wherein electric wire connections are made. There are hundreds of these openings in the entire length of the tunnel, and the side walls and roofs of these openings are all surrounded by a wall of reinforced concrete. In another instance the material is being used to bond together two thin walls of concrete enclosing electric wire conduits.

Expanded metal seems to have met with special favor by builders of sugar refineries in this country. There are no less than half a dozen factories in the East as well as in the West that have been fireproofed on this system. This list includes the New York Sugar Refinery Company on Long Island, the National Sugar Refinery of Yonkers, N. Y., the Alma Sugar Company's factory at Alma, Mich., and the Bay Side Sugar Company's building at Bay Side, Mich., the Oxford Beet Sugar Mill in California, besides others in Nebraska.

The question of the desirability of furring off from walls as a means of fire protection is one concerning which architects differ. A test was made some years ago in Boston, indicating that where the furring is upon a wood surface that it really is not of advantage. In the case referred to a series of tests was made by Mr. Chas. L. Norton, of the Massachusetts Institute of Technology, for the Associated Factory Mutual Fire Insurance Companies. In this case a part of the test was made by furring with wood strips, and over them lathing with expanded metal and plastering. In certain other portions the lathing was applied directly to the wood surface. In the details of his report Mr. Norton makes use of the following sentences:

"Attention is called to the increase in charring back of the expanded metal when furred off over the charring when nailed closely to the planks. It is clearly indicated that furring spaces back of fire retardents are not desirable."

Expanded Metal in Bridges

THE combination of steel and concrete for the erection of bridges is now one of the most general uses to which these materials have been put in their combined form. A great many engineers throughout the country have designed concrete steel bridges, and strong claims are made for the various plans. In the ancient days concrete was used alone for bridge construction, and many arch bridges of this material are still in use, although thousands of years old.

For the past twenty-five years in America steel alone has been the ruling material for bridge construction, and large combinations of capital are carrying on the business constantly. However, the greatest economy has been proven in the combination of the two materials. The desirable results of the combination are not alone those of economy in the cost. Much more effective results can be gained, besides a much longer guaranteed life.

The efficiency of expanded metal for the steel member of this combination has been proven in many ways. We show only a few illustrations representing instances wherein our material has been used for the purpose in question.

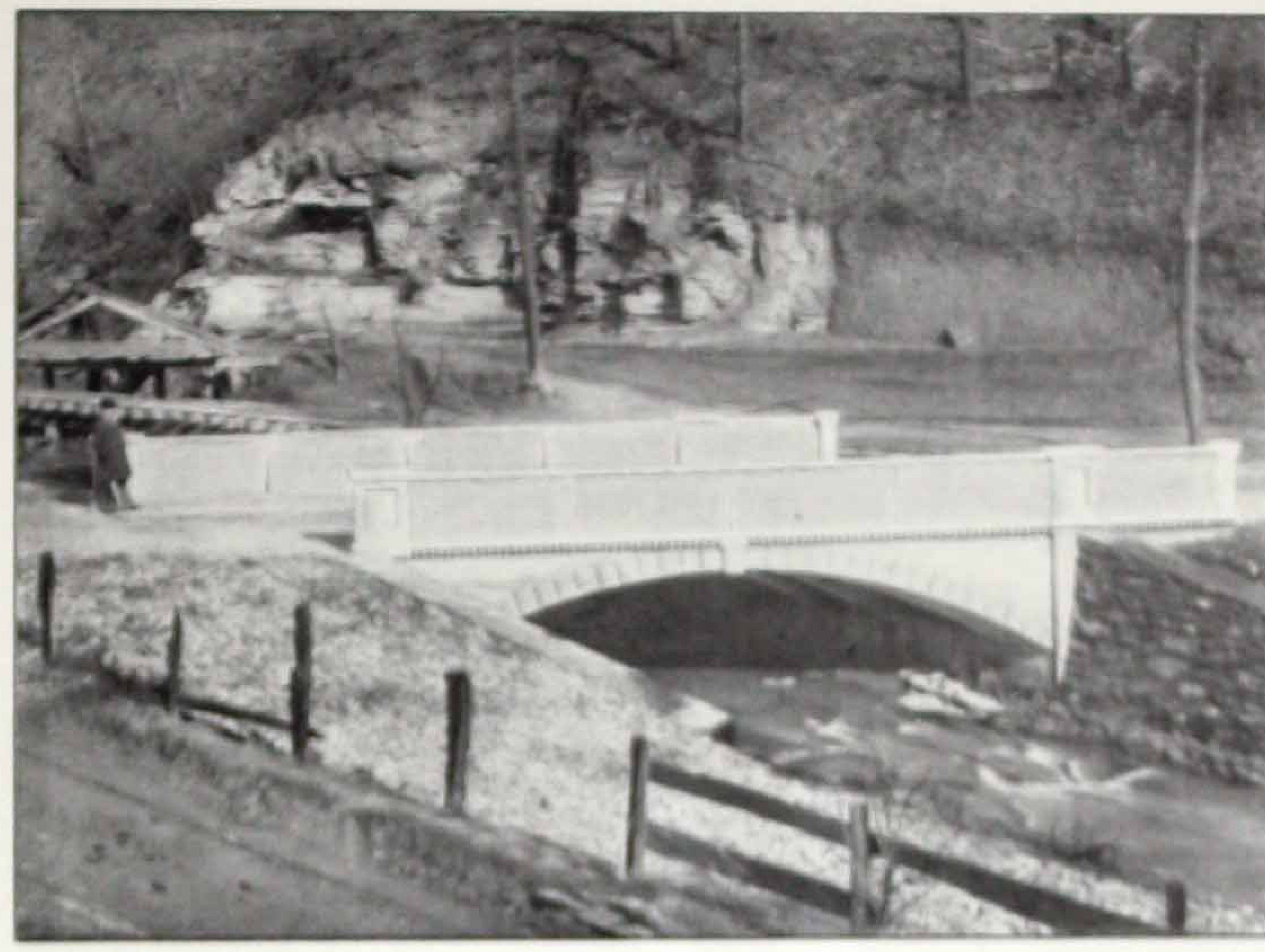


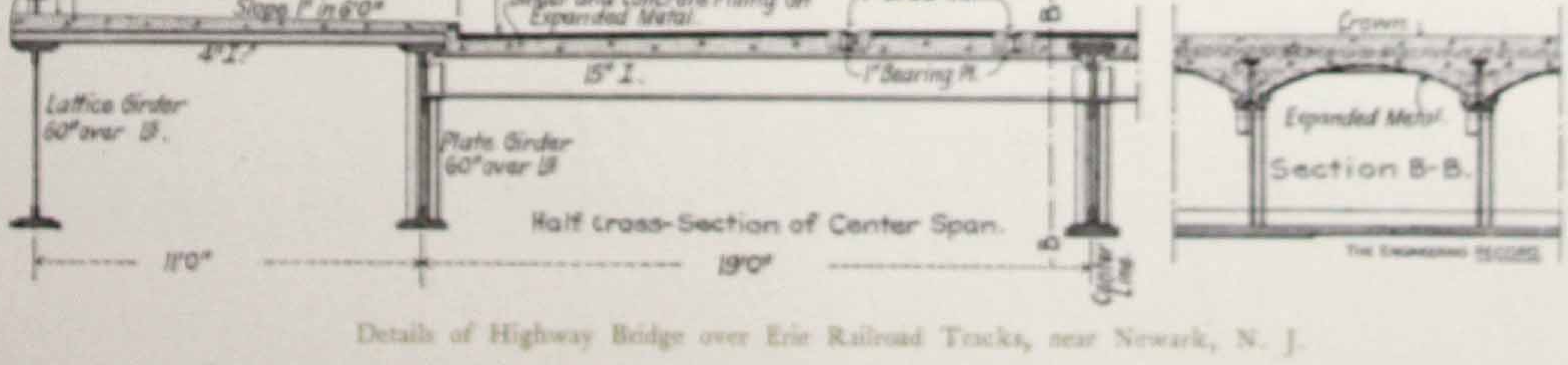
Fig. 1. Expanded Metal-Concrete Highway Bridge, near Pittsburgh, Pa.

In Fig. 1 we show a highway bridge erected several years ago in Alleghany County, near Pittsburgh, Pa., under the supervision of T. W. Paterson, Engineer of County Roads. This bridge is built on a skew of 38 degrees. The rise of the arch is 4 feet 1 inch, and the span of the bridge is 20 feet. The durability of the structure is, of course, unquestionable, and its appearance in every way tasty and agreeable.

Plate Girder Highway Bridge

On Kearney Avenue, Newark, N. J., there was built, in the year 1899, a highway bridge over the tracks of the Erie Railroad. The structure was designed to carry two lines of electric railway cars, a carriageway and sidewalks. Its total length between abutments was 134 feet. Floorbeams, 15 inches deep and 6½ feet apart, are web-connected to the girders to carry the roadway, and 4-inch I-beams, 4 feet apart, are set on top of the girders to carry the sidewalks.

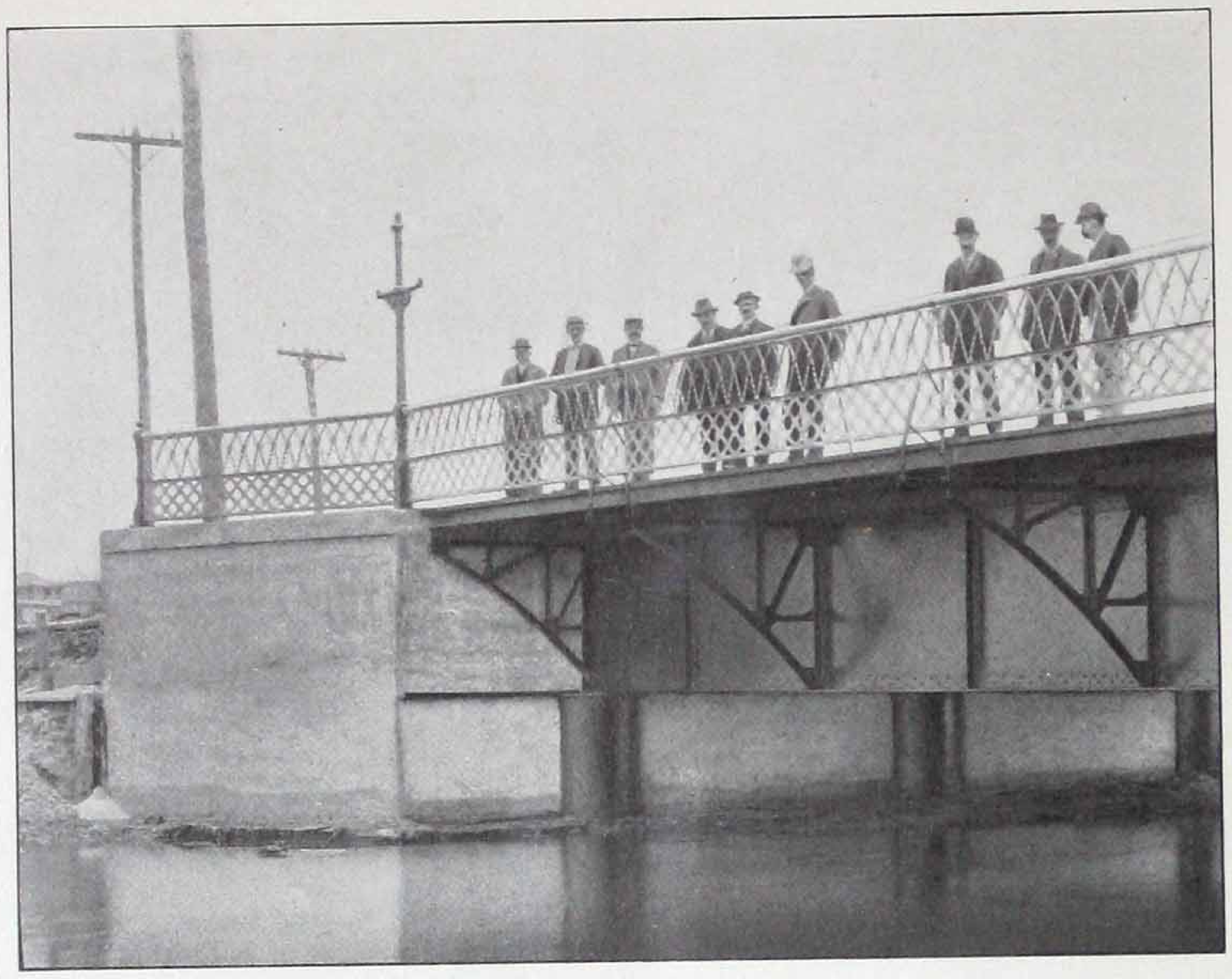
The lower flanges of the roadway floorbeams were wrapped with expanded metal lath, and sheets of 3-inch No. 10 metal were sprung between them to form the soffits of segmental arches of 14 inches rise. Concrete arches were built on these soffits, enclosing all the upper portions of the floorbeams and reaching several inches above their upper flanges. The concrete was made 1:2½:6 of American Portland cement, sand and boiler furnace cinders, well rammed. After the concrete had set and the centers were removed, the lower flanges of the floorbeams were plastered with 1 inch of cement mortar and the intrados of the arch was floated. The street car rails were laid,



Details of Highway Bridge over Erie Railroad Tracks, near Newark, N. J.

rows of granite blocks were set on each side of them, and the remainder of the roadway surface was covered with an asphalt pavement of the usual construction. The sidewalk beams were wrapped with metal lath and embedded in solid slabs of cinder concrete like that used for the roadway arches, and covered with ¾ inch of 1:1 Portland cement mortar.

This work was under direction of Mr. C. W. Buchholz, Chief Engineer, and Mr. M. R. Strong, Bridge Engineer. Since the erection of this bridge a still larger one was constructed for the same railroad company at Binghamton, N. Y. Also a smaller one at Caldwell, N. J., in both of which the same type of construction was adopted.



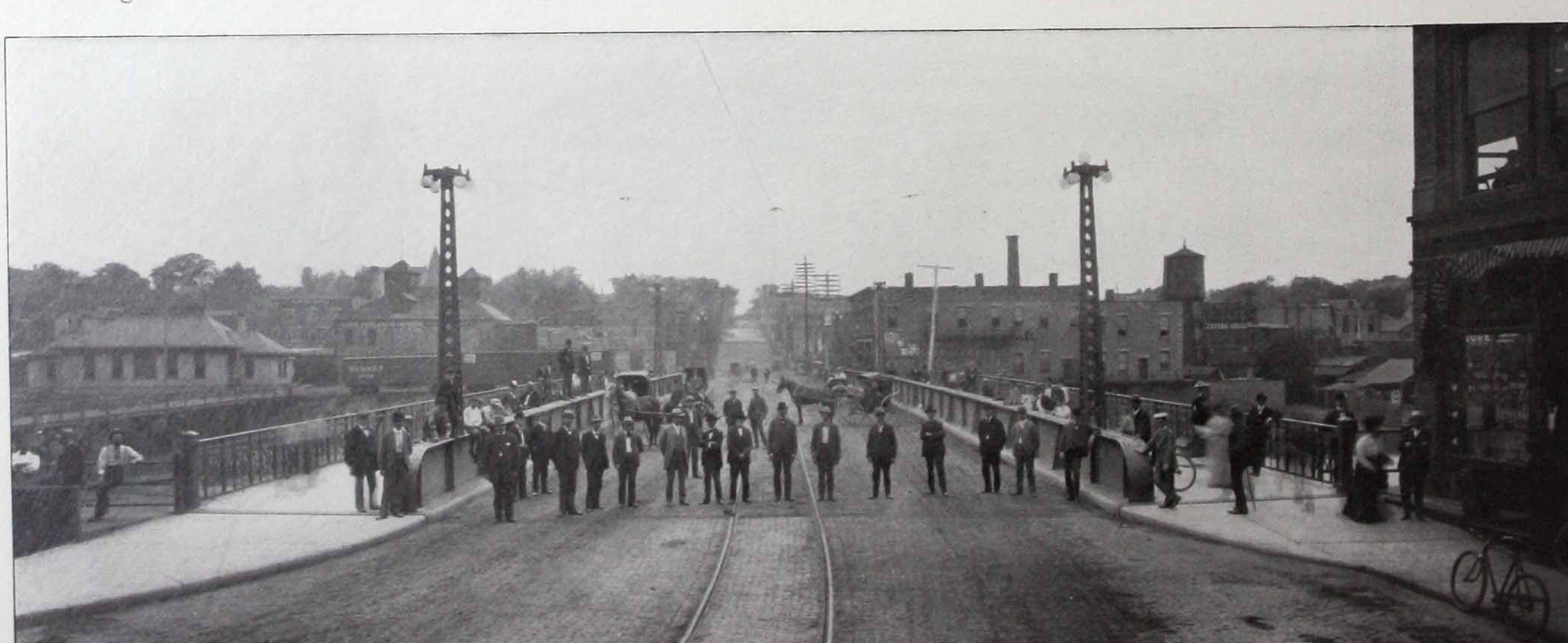
Expanded Metal-Concrete Abutments and Retaining Walls, Sea Girt, N. J.

Bridge Piers and Retaining Walls

In the year 1899 there was constructed at Sea Girt, N. J., a steel bridge or public highway wherein concrete and expanded metal piers and retaining walls were adopted in substitution for stone masonry construction, as originally designed. The work in question, which is shown in the accompanying illustration, was designed by the Berlin Iron Bridge Company, whose proposal substituted steel caissons filled in with concrete for the support of their plate girders, while the retaining walls were constructed of concrete and expanded metal. Their design was accepted with a very marked degree of economy to the county. The appearance of the abutments and retaining walls was very pleasing as compared with rough stone masonry, and have answered every demand made upon them. Since this a number of other bridges have been built on the same type of construction.

Concrete Arch Bridge

The illustration on page 13 shows a very tasty design of concrete arch bridge, built for Mr. P. D. Armour, Jr., at his summer residence at Oconomowoc, Wis. The bridge in question was designed by Mr. C. F. Hall, C. E., of Chicago. The structure is 60 feet long over all, 15 feet wide at the center, the roadway widening to 17 feet at each



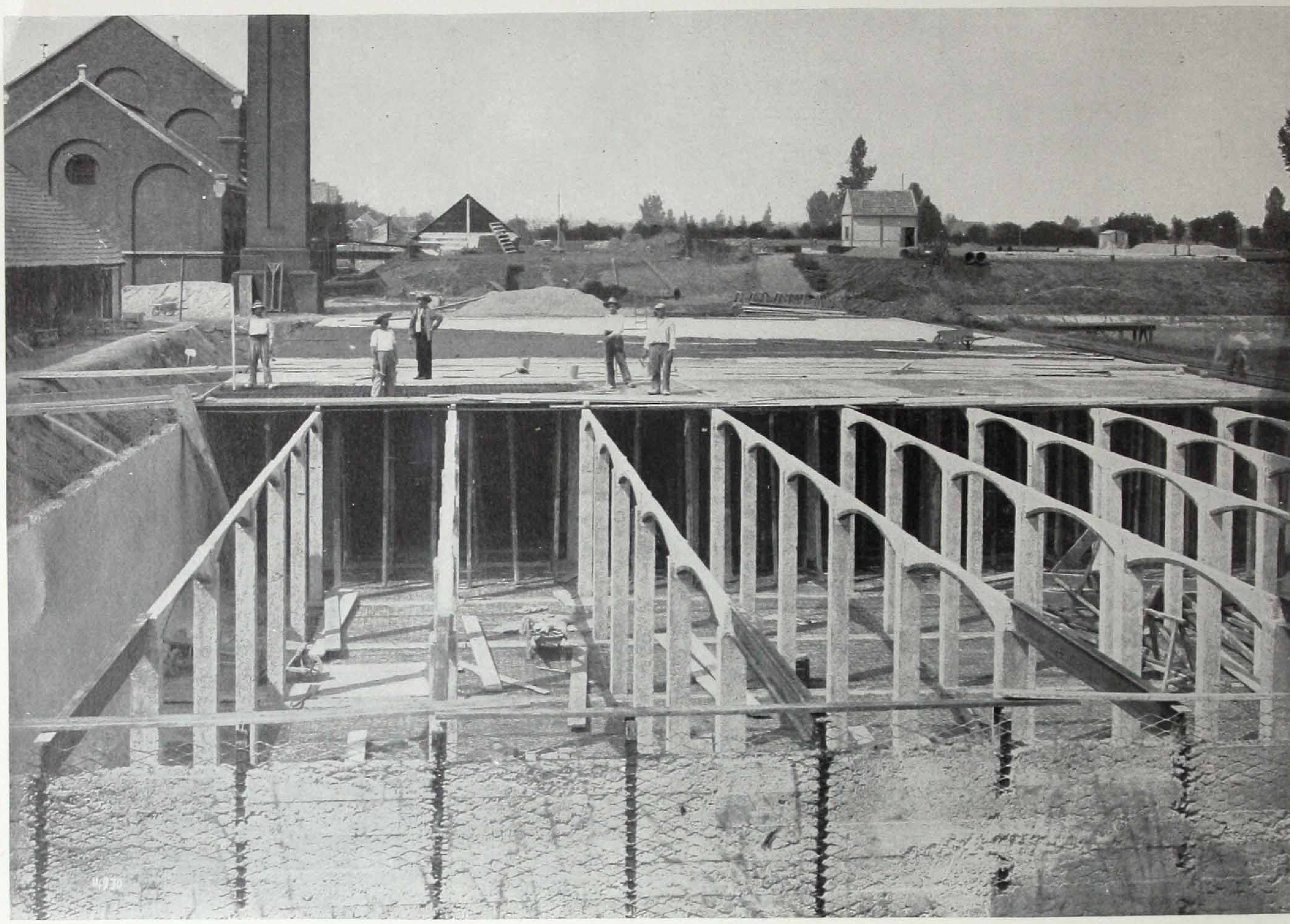
Expanded Metal-Concrete Bridge Floors, Elgin, Ill.

end, and is constructed as follows: The abutments rest upon driven piles, the head of the piling projecting 6 inches into the concrete. False centering was first erected, over which the arch was built. A steel truss beam, conforming to the curve of the arch and embedded in the floor space, was placed in position on either side of the false work; ⅜-inch steel rods were then laid 1 foot from centers, from beam to beam, and fastened by bending the ends of the rods over the truss. Expanded metal was then laid over the rods and fastened to the same and to each truss-beam, producing the most excellent metal alignment. The concrete was next put in place, all concrete used being composed of one part of Vulcanite Portland cement, three parts gravel and four parts crushed stone. The concrete floor is 6 feet thick at the crown, increasing to 8 inches at the spring of the arch. A concrete beam 18 inches thick was formed on either side of the roadbed, 2 feet deep at the crown, increasing to 3 feet 6 inches in depth at the spring, in

Concrete Arch Bridge at Oconomowoc, Wis.

which the steel truss is embedded and extending 3 inches below the surface of the arch. This beam rises above the roadway to form the rail and widens out with the roadbed as it descends toward either end, terminating in the form of a graceful spiral curve on the surface of the projecting abutment. Cast-iron standards are embedded in the railing, forming a metal guard rail 22 inches high, each panel being completed by a top rail of wrought-iron pipe. The false centering was removed ten days after the concrete was finished. All exposed surfaces were faced with a thin coat of Portland cement mortar, a like mortar having been previously placed along all outer sides of the concrete. The work, style and finish is in every respect first class, being entirely satisfactory to the owner, and reflects credit upon Messrs. Stamsen & Blome, the contractors for the work.

A Remarkable Reservoir



Water Reservoir at Antwerp, Belgium

THE Antwerp Waterworks Company, an English undertaking, supplying water to the city of Antwerp, in Belgium, has recently set an example of what freedom from the trammels of old-fashioned ideas can accomplish in reservoir construction. They have built a rectangular or box-shaped covered reservoir to contain 660,000 gallons of water under conditions which the combined use of expanded metal and concrete could alone fulfill. This reservoir, which is 12 feet deep from the underside of its floor to the flat surface of its roof, is entirely buried below ground level in a water-logged soil.

In designing the construction, calculation had to be made for an upward and external pressure of 600 pounds per square foot of the floor of the reservoir when empty, necessitating an added load of 300 pounds of soil per square foot spread over its flat roof to prevent its floating.

In view of the novelty of the design the Antwerp Waterworks Company consulted M. de Tedesco, the well-known French authority on iron and concrete constructions, and the work was carried out by M. Chassin, a prominent French contractor, from M. de Tedesco's plans and specifications. The floor of the reservoir is composed of Portland cement concrete, 1 foot thick, laid on a foundation of broken bricks roughly levelled. Steel girders of "I" section, measuring 9 inches by 4 inches, are laid in parallel lines 7 feet 8 inches apart from end to end of the floor, the length of the floor being 164 feet and its breadth 65 feet 6 inches. Sheets of expanded metal of 3 inches mesh, weighing 6¼ pounds per square yard, are laid to form a continuous binding both above and below the steel

joists, so that the finished floor is an immense concrete slab with steel ribs and expanded metal binding on its two faces, making it equally rigid against pressure from above or below. Square columns 7 inches by 7 inches rise from over the floor girders at distances of 10 feet 4 inches. These columns are composed of steel joists of "I" section 5½ inches by 2½ inches, encased in concrete. The walls are of concrete 7 inches thick throughout with a binding of expanded metal on each face, and stiffened by vertical "I" joists 5½ inches by 2½ inches placed 5 feet apart on the long sides and 3 feet 9 inches apart at the two ends of the reservoir. Ties formed of 1½ inches by 1½ inches angle irons cross the floor from side to side at each row of columns. The roof is made on the Golding arched floor system, the arches being of concrete on 4-inch channel irons, 10 feet 4 inches span with a rise of 12 inches, and the slab floor of concrete, 5½ inches thick, with a binding of expanded metal of 3-inch mesh, weighing 12 pounds to the yard, on its underside only. The floor has a carrying span of 7 feet 8 inches from center to center of the arched ribs. In the two end bays of the reservoir the channel arches are replaced by straight "I" girders, 10 inches by 4 inches, buried in a concrete floor 12 inches thick with expanded metal binding on both faces. These heavy ends of the reservoir roof act as buttresses to take up the thrust of the arches. The concrete work is finished inside and outside with a carefully troweled rendering of neat cement. On completion the whole construction was loaded down with 3 feet of soil spread over the roof. The reservoir forms a complete box, the walls being vertically placed slabs supported against lateral thrust by the floor and the roof, the whole structure being so braced together by expanded metal that it would float without leaking and would carry its full quantity of 3,000 tons of water without any outside earth backing.

The work was excellently carried out by the contractor in the specified time of three months. Its total cost was Fcs. 85,000, or about $17,000—a very moderate cost for a first construction of this kind, which, owing to its novelty, was placed in the hands of the most reliable contractor and not submitted to competition. A circular tank of equal capacity would have cost considerably less if made in concrete and expanded metal, but space would not permit of the circular form.

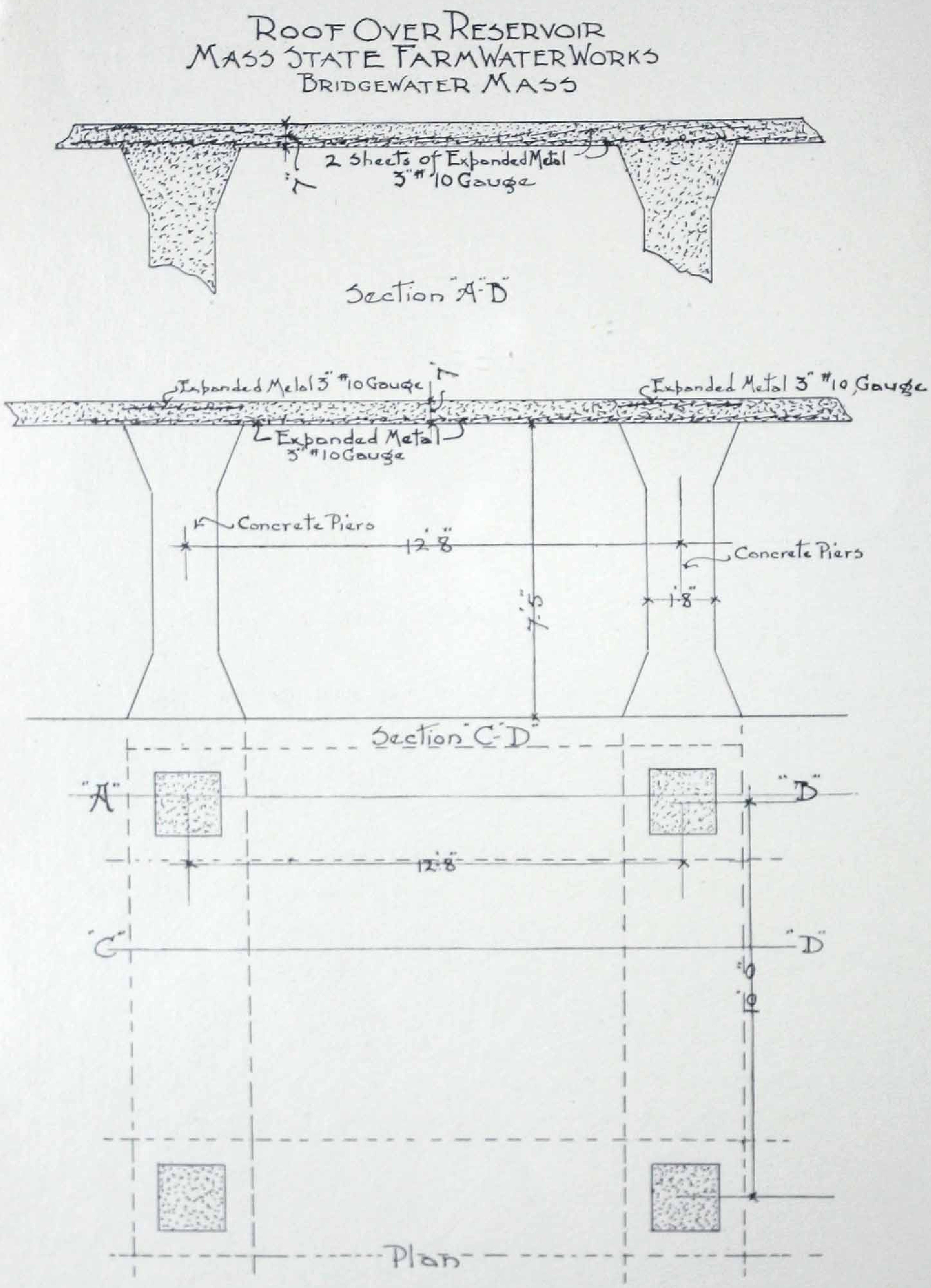
A detailed description of this reservoir appeared in the "La Revue Technique" of September 10, 1900.

It may be stated in a line that expanded metal is a standard material in government specifications. For many years past our material has been regularly specified for lathing purposes in all of the work executed by the architect of the Treasury Department, and within the past few years it has become a standard material in specifications in all of the Navy Yards on both the Atlantic and Pacific Coast, and is being used for buildings of all varieties in such yards. In the New York Yard it has been used to the extent of many thousands of feet in the erection of new and improvement of old buildings to the number of nearly twenty in all. The material is also being used quite largely in the specifications of Mr. Ernest Flagg, the architect, in the erection of the new Naval Academy at Annapolis, Md., where the government is expending several millions of dollars for the improvement of the United States Naval Academy.

One of the largest uses for expanded metal to-day, and one which is growing very rapidly, is in connection with the building of what is termed cementine construction. This type of construction is nothing more or less than a frame house, as if for ordinary weather boarding. Instead of this, however, the exterior surface is properly furred and then covered with expanded metal lath upon which is built a permanent surface of first quality cement mortar. Almost any effect and feature in this can be accomplished, according to the notions of the architect. The economy is manifest in many ways. The construction is very little more expensive than wood, and gives many opportunities unobtainable in brick construction. By the same method old buildings are easily transformed from tumbledown affairs to structures of utility and beauty.

A Reservoir Roof

THERE has recently been constructed at the Massachusetts State farm, at Bridgewater, a concrete reservoir, in which there was employed the principles of expanded metal construction. The accompanying illustration shows the character of the roof of this reservoir. The structure was built by Freeman C. Coffin, hydraulic and civil engineer, Boston, and the details of this roof were designed by him. The reservoir covering is semi-circular in shape, being 65 feet in diameter, and the piers are all of concrete of the same mixture as that employed in the roof, and the proportions of same were one part Portland cement, two parts sand and five parts screened bank gravel, sizes ¼ to 1½ inches. The columns are 30 inches square at the top and bottom, and 18 inches in the middle sections, as shown in the drawings. The roof concrete is 7 inches thick and was designed to carry a breaking load of 1,200 pounds per square foot. The expanded metal employed was 3-inch mesh No. 10 steel, and was placed double over the lintels, or from one pier to another. As indicated through the lower portion of the spans, which are on units of 12 feet 8 x 10 inches, the expanded metal was placed in the lower part of the slab, while from pier to pier in each direction a strip of metal 30 inches wide was placed near to the top of the slab.



The accompanying partial plan and sections clearly show the construction.

One of the first instances in which expanded metal was used was in connection with a reservoir, in the fall of 1893, when a roof was built over a big reservoir at Rockford, Illinois. This reservoir was 156 feet long and 68 feet wide.

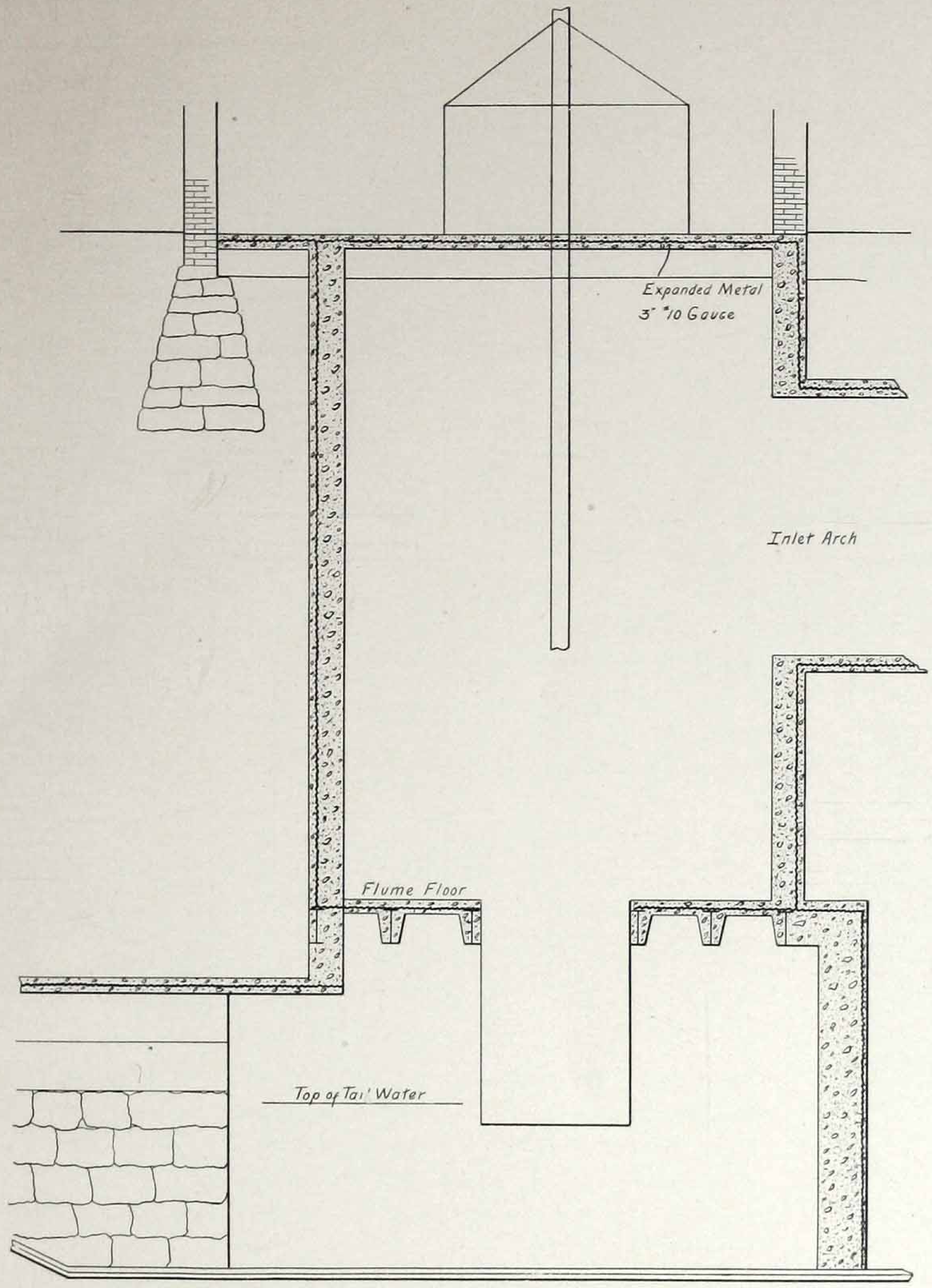


Fig. 1. Section of Wheel Pit and Flume, at Walpole, Mass.

In a Wheel Pit

ONE of the most interesting combinations from an engineering standpoint which has been accomplished in concrete-expanded metal construction is shown in the accompanying illustration, which is a wheel pit, including an inlet arch, flume floor, generator floors and tail race, recently erected for the Massachusetts Chemical Company at Walpole, Mass. The sectional illustration shows the general form of the work. The wheel pit is 13 feet in diameter, the inlet arch being 8 feet in diameter. The tail race is a comparatively shallow conduit 15 feet in width, and is covered by a segment arch formed of concrete and expanded metal.

In another illustration herewith we show reproduction of photograph of the wheel pit in course of construction.

The entire work was carried out to the satisfaction of the company in question, and they are now using the same general scheme of construction for other work of a similar character at their plant.

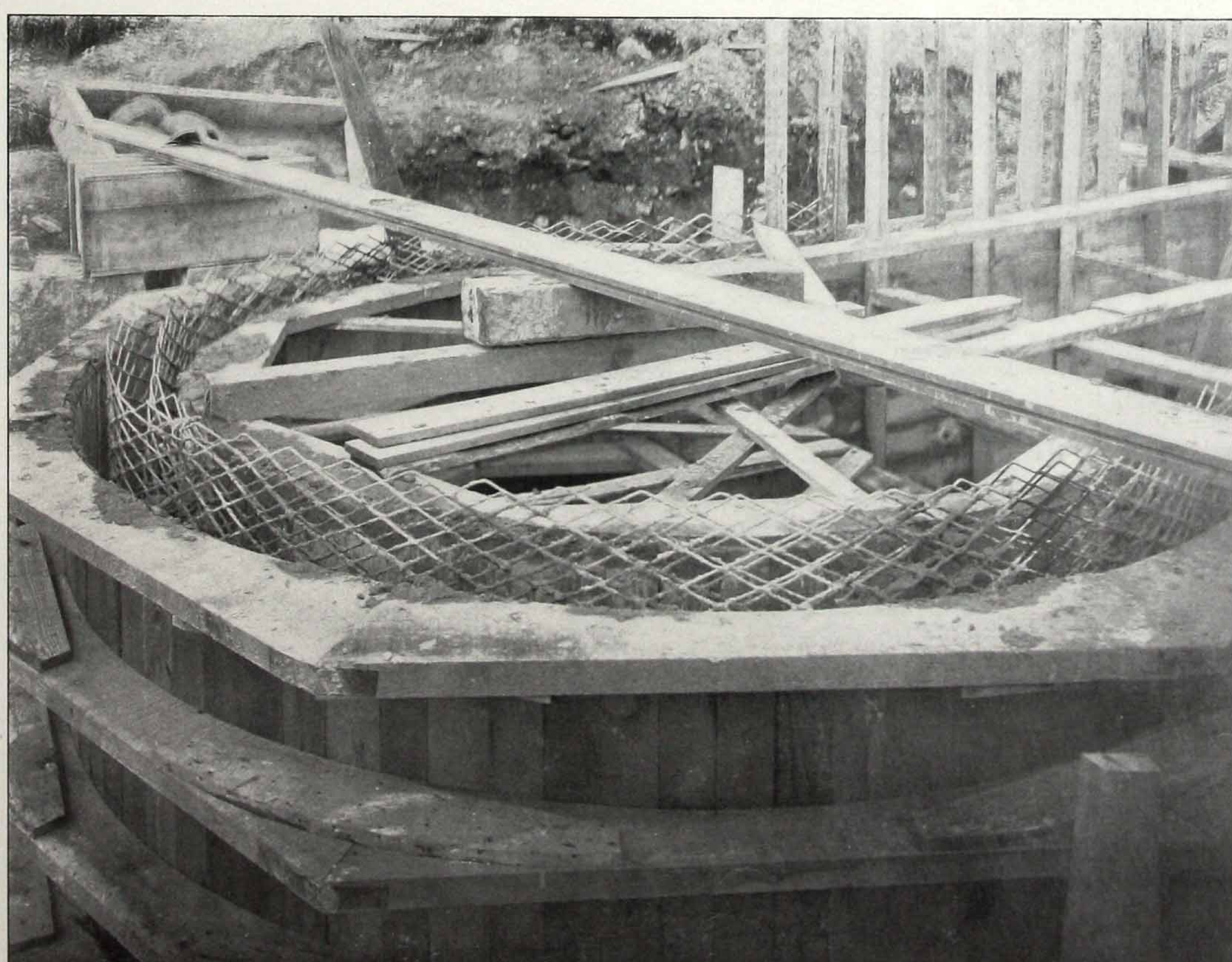


Fig. 2. Wheel Pit in Course of Construction

A Water Conduit

IN the securing of a new permanent water supply for Jersey City, from a large storage reservoir now being erected at Boonton, N. J., it became necessary to convey the water through many miles of conduits, tunnels and steel pipe. For the conduit section it was originally intended to use brick arches; this was afterwards modified to a concrete arch, and later changed to a combination of concrete and expanded metal. As originally designed by Mr. E. W. Harrison, Consulting Engineer of the Jersey City Water Supply Company, the conduit section was intended to be constructed 12 inches thick at its top or smaller dimension. There was erected in May, 1900, a test section of the combined concrete and expanded metal type, the section being 10 feet in length. As compared with the all-concrete section, it contained 1 cubic yard per lineal foot of pipe section as compared with 2 cubic yards for the original. The new section was reinforced with expanded metal in the manner indicated in the figure accompanying this article.

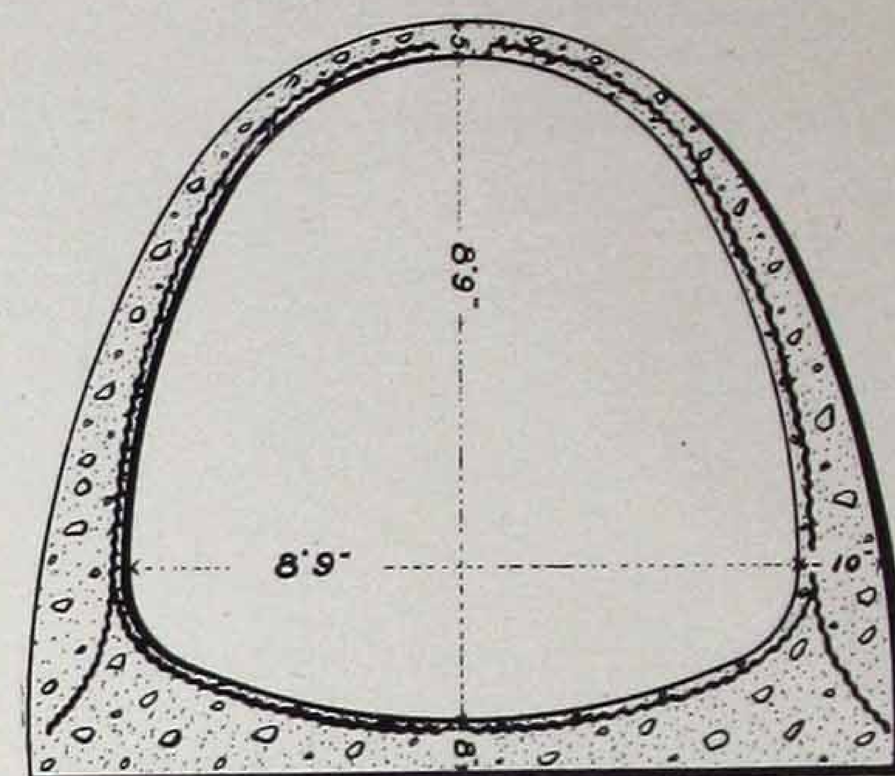


Fig. 1. Section of Water Conduit at Boonton, N. J.

The design, as shown, is practically an ellipse with the haunches and bottom forming an inverted arch. The material used was crushed stone 1½ inches, 1-inch screenings and sharp pit sand, and the mass was in proportions of one cement, two of sand and five of broken stone. At the age of thirty days after building the section in question was tested under supervision of the company's engineers.

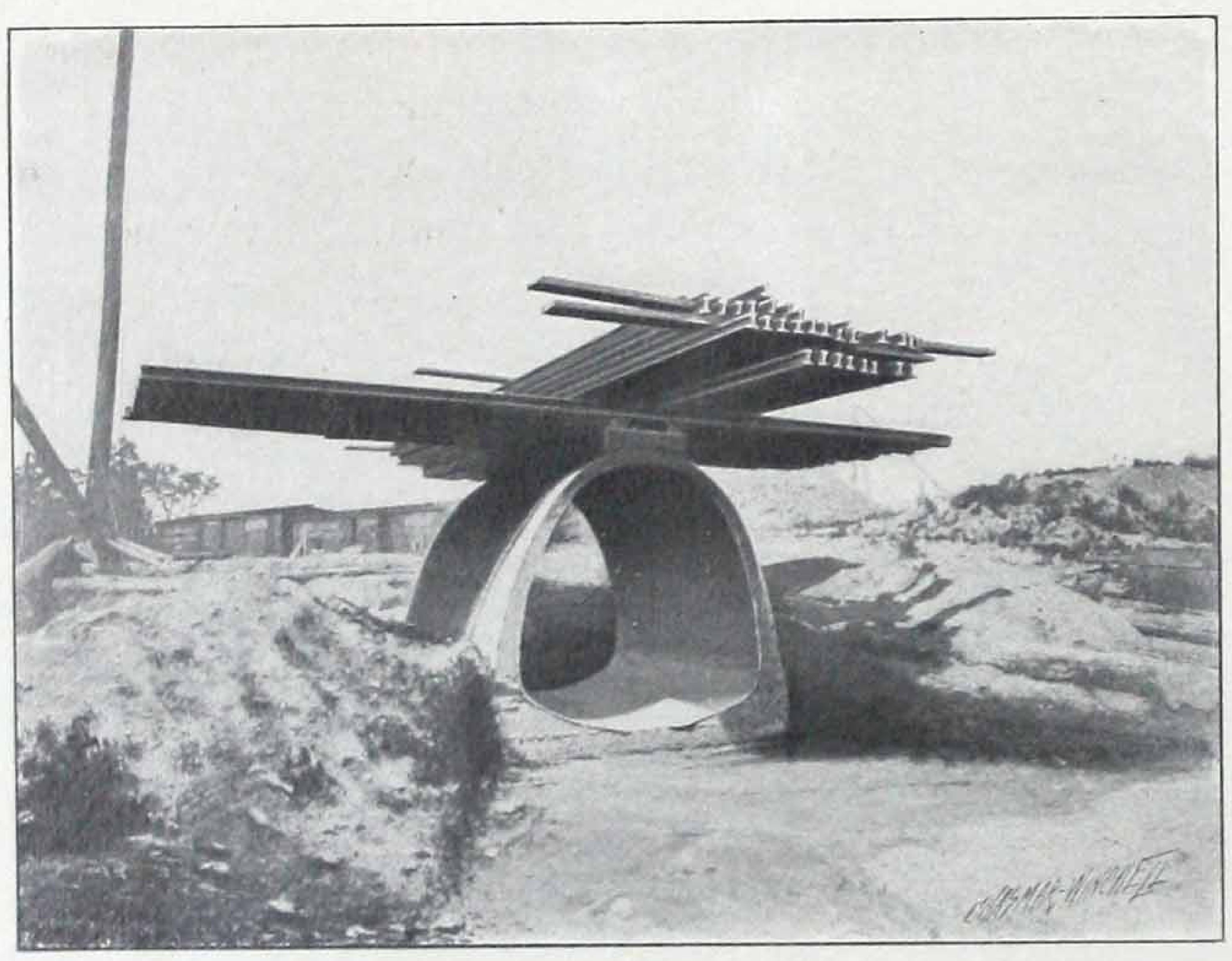


Fig. 2. Section of Water Conduit Loaded with 25 Tons of Steel Rails.

Three saddles of timber had been set on the crown of the arch, shown in Fig. 2, one in the center and one at each end, and one layer of nine rails had been laid on these saddles. The actual test began at 2:45 p. m., laying rails on, one by one, while a level had been set up to determine any deflection. At 5:28 p. m., with a load of 21½ tons, fine horizontal cracks began to show all along the extrado, but no measurable deflection took place.

When the load had been increased to 25 tons, as shown in Fig. 2, three rails, weighing approximately 1 ton, were twice dropped on the rails on top of the arch over one end of the latter. The cracks were slightly widened and new fine cracks showed at the intrado and at the haunches, running all along inside the conduit section. When the rails were being dropped the level had been removed to avoid damage to the same.

The clear height of the section having been measured directly before the beginning of laying on rails, the same was measured over again twenty-four hours after completion of the test, and the total deflection at the crown of the arch was seven-sixteenths inches, and has not increased since (to July 16) under the constant load.

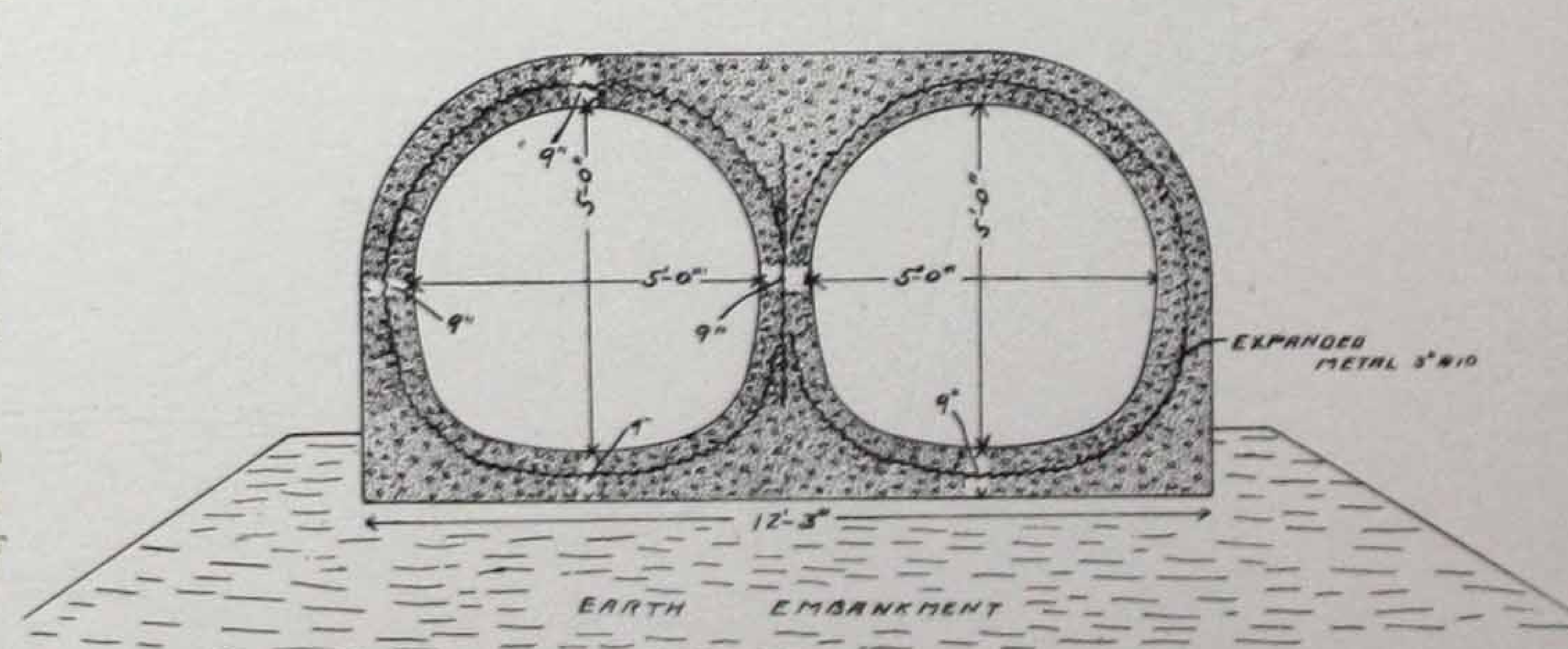
As a result of the above test, the construction was approved and contract has been let for this construction to the extent of about four miles, and the same is now under progress.

In a Newark Reservoir

Nearby, geographically, to the water conduit of the Jersey City Water Supply Company, named above, there is being built a new storage reservoir by the Department of Water of the City of Newark, to be known as the Cedar Grove Reservoir. For this work Morris R. Sherrerd is chief engineer.

In the erection of this reservoir a certain amount of conduit was requisite, in some places the section being single and in other places double. We show herewith a view of the double section, which is to be erected upon an earth embankment.

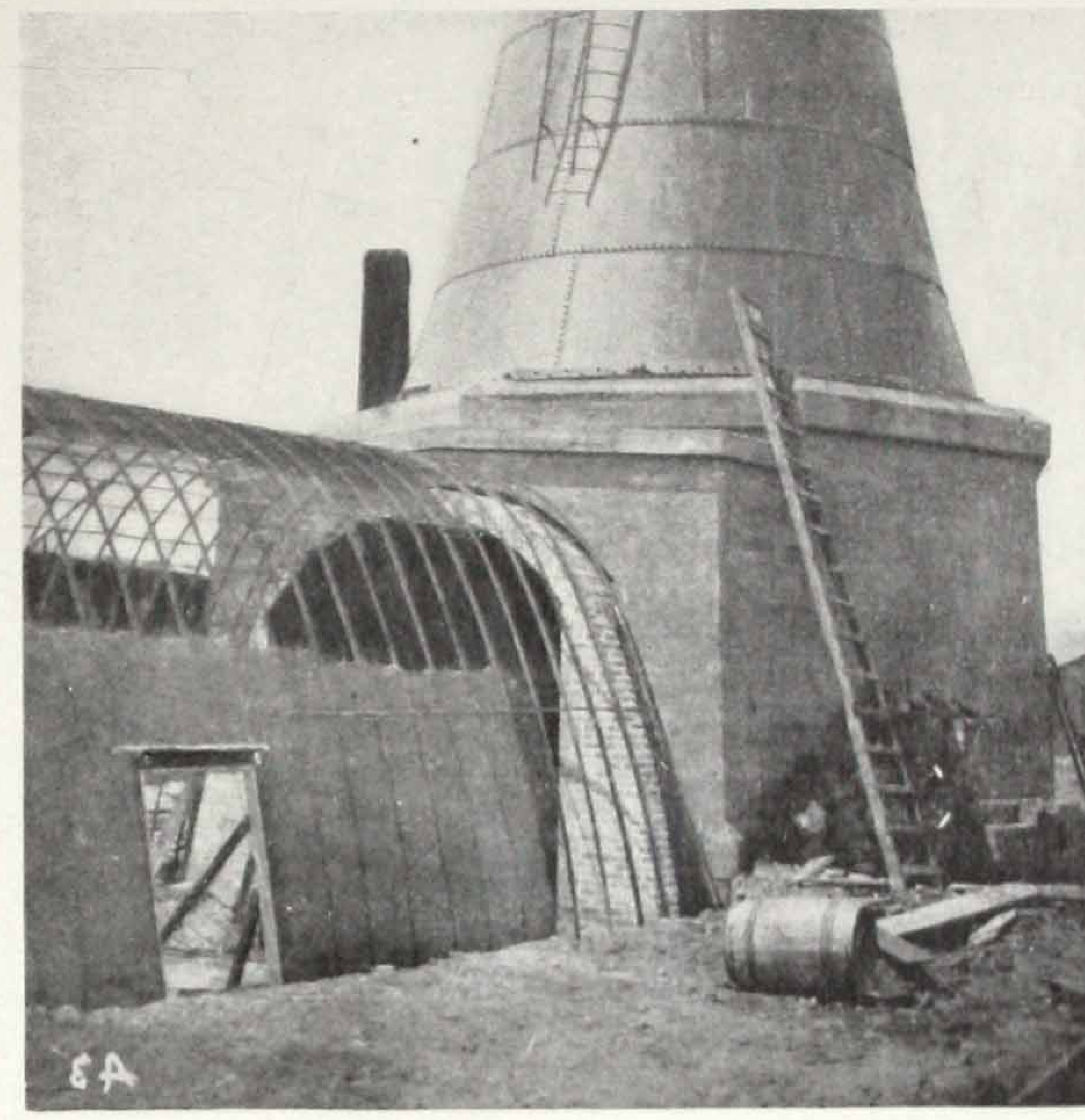
In this contract, which has recently been let, there is more than a mile of the conduit to be erected calling for the consumption of 165,000 square feet of 3-inch No. 10 expanded metal.



Twin Water Conduit, Newark, N. J., Reservoir

Dust Flume Construction

A NOVEL use of concrete-steel construction is exhibited at the works of the Arkansas Valley Smelting Company, at Leadville, Colo., where the dust flue conveying the smoke and gases from the roasting furnaces to the chimney is built of concrete, with an embedded metal skeleton. The flue is U-shaped in plan, with one leg of the U shorter than the other. The sulphurous gases from the roasting furnaces enter the short leg of the U from a tunnel below, pass around the loop, being somewhat cooled, and depositing in the passage the valuable dust which they contain, and, finally, pass out of the chimney into which the long leg of the U enters. Brick riffle walls placed at intervals across the bottom of the flue aid in collecting the dust. The flue was designed by Mr. E. H. Messiter, the engineer of the company.



Concrete and Steel Dust Flue

The construction of this flume is quite readily seen by the single accompanying illustration. The main arch members of the flume are simply iron channel bars bent to an arch and having their ends set in concrete base wall. Between these walls is a concrete floor resting directly on the ground. The channel-iron arches are connected longitudinally by flat iron members connected to the channels by clinched staples. To this is fastened the expanded metal, forming a skeleton on which the concrete mixture is applied, making a total thickness of 2½ inches. The inside of the wall was finished with a neat cement wash. The construction proved entirely satisfactory for the purpose desired, and was economical in accomplishment. Other similar work has been accomplished in the mining regions of the West and in Mexico.

In Shipbuilding Yards

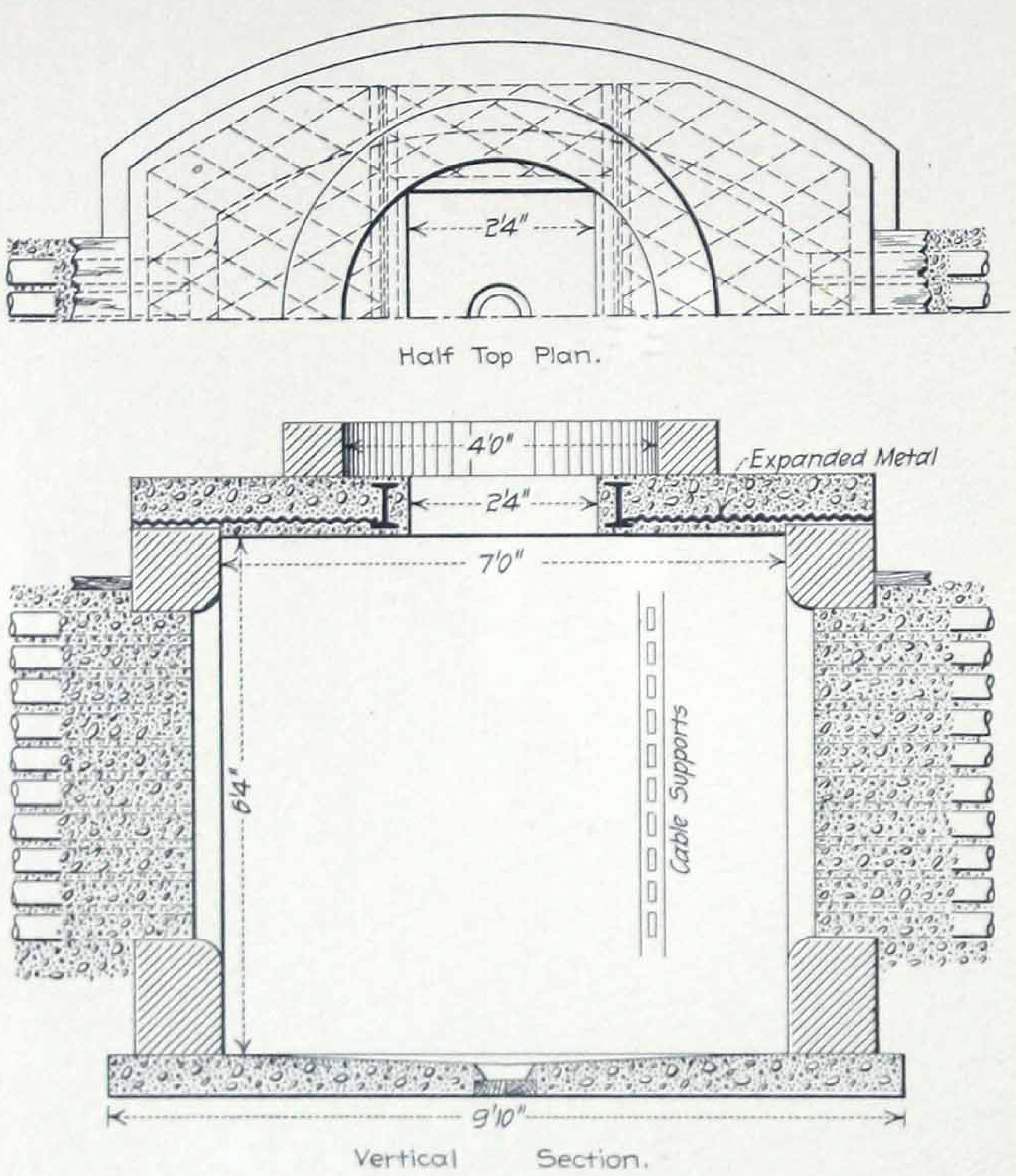
At the William Cramp & Son's Ship and Engine Building Company, Philadelphia, expanded metal enters largely into the construction of the new electric power house at the northwest corner of Plum and Clairbourne Streets. Both the first and second floors in this building are of expanded metal and concrete, and one gable end, 57 feet wide and 85 feet 10 inches high to the peak of the roof, is of expanded metal lath carried upon steel channel studs and plastered two inches thick with Portland cement.

At the new works of the New York Shipbuilding Company, Camden, N. J., a large use is being made of these two-inch "solid partitions." One of them between the mould loft and angle smith's shop is 506 feet long, in a straight line, and 28 feet 6 inches high. Another partition between the machine shop and the launchway is 415 feet in length, by 15 feet 6 inches in height. In order to clear the traveling crane in the machine shop, the lower part of this partition, to a height of 3 feet, inclines at an angle of 45 degrees. The remaining 12 feet 6 inches of the partition is vertical.

There are about 2,000 square yards of expanded metal partitions in the joiner shop, and the upper portion of one of the exterior walls of the machine shop has been constructed in the same way. The expanded metal work in this case is 440 feet long by 16 feet 8 inches high, and was set upon the top of a brick wall 42 feet high. The tool room, which extends for 200 feet along one side of the machine shop, is separated from the latter by an enclosure of 1½ x 3 inch mesh expanded metal, cut from No. 12 gauge steel. In the basement of the office building are ninety-seven lockers or clothes closets for the use of the drafting and clerical force. These also are made of expanded metal.

Subway Manhole

IN the larger cities throughout the United States, for several years past, it has been mandatory that all electric wires of whatever description be placed underground. This is accomplished by the laying of many lines of cables in subways. For the convenience of handling this traffic it is necessary to build openings or manholes at not greater than 300 feet distances along the streets. Of course the manhole itself is an opening large enough only to enable a workman to get down into the subway proper, but it is necessary to build a chamber with dimensions large enough to enable several men to perform the necessary work. The very great consideration in the building of the proper cover of this chamber is that it will consume as little space as possible, making the largest obtainable room for operations. Moreover, an important consideration is, that when once erected, there will be no trouble in its care, and no limit to its durability.



Standard Manhole for Union Subway Company, New York

The most popular style of construction for years past has been I-beams, with the buckle-plate scheme of construction, upon which the concrete and cobble stones of the roadway above are carried. This was not only expensive in first cost, but also in maintenance, and also in addition consumed room.

The engineers of the Union Subway Company, New York, after experimenting have adopted a manhole cover of expanded metal and concrete, effecting not only very considerable economy, but have secured the desired result indicated above. In our illustration is shown a half-top plan and vertical section of the work which is now being installed in all of their new work.

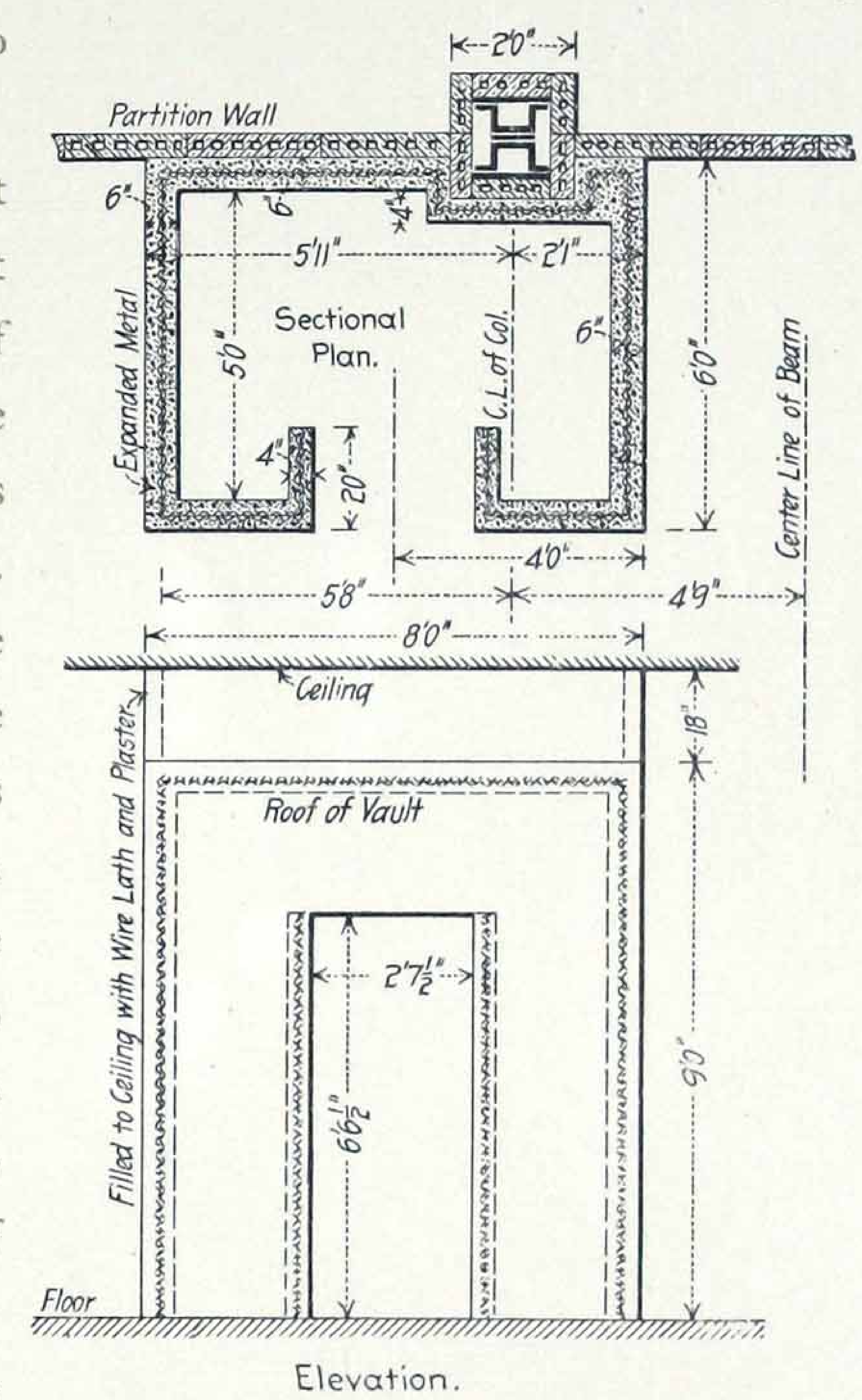
When it is considered that in New York City, as well as many of the larger cities of the country, all telephone and telegraph wires are necessarily carried in subways, and that there are on the average twenty manholes per mile, it will be seen that an economy of even a few dollars per manhole aggregates a very considerable sum in this important business. The definite manner in which the expanded metal supports the concrete, in connection with the I-beams, is so clearly shown by the two illustrations, that detailed description is not necessary. Suffice it to say that the first one built in New York City, several months ago, has proven entirely satisfactory, and this system is now adopted as standard for manhole construction in New York City. It was built by the Union Subway Company, of which Clement S. Walker is Chief Engineer.

A concrete and expanded metal bottom was recently constructed in a wheel pit built by Chas. D. Parker, in Worcester, Mass. The desired levels for the pit opened up a bed of fine, lively quicksand, which was excavated in the usual way by driving sheet-piling. Over this bottom was then built a plate of concrete reinforced by expanded metal, and the walls of the pit were built directly upon this plate, so that the whole mass was held down and the anticipated trouble neatly obviated.

A Fireproof Vault

WE illustrate herewith a fireproof vault recently built for the Domestic Exchange National Bank, of New York, by the New York Expanded Metal Company. The bank occupies a portion of the third floor of the new fireproof building known as the "Broadway-Chambers," corner of Broadway and Chambers Street, and a vault was desired that should be of sufficient fire-resisting quality to withstand any fire likely to arise in such a fireproof building, that should not be too heavy to be supported by the floor of the room, that should not waste too much room in thickness of its walls, and that should be reasonable in cost. Different vault builders proposed styles of vault which did not satisfy one or more of these requirements. These included vaults built of two thicknesses of boiler-plate steel, separated 3 or 4 inches, and the space filled with plaster and brick, and vaults of brickwork varying all the way from a single thickness of cellular firebrick, 4 inches thick, up to solid brick walls, 2 feet thick.

A suggestion was made by Mr. William Kent that a suitable vault could be constructed of a combination of expanded metal and Portland cement concrete of the same kind as is used in fireproof flooring, viz., the mixture of one part cement, two of sand and four of coal ashes. This mixture, in the tests made by the New York Building Department some two or three years ago, showed remarkable resistance to fire and to heavy loads at the same time. The vault was constructed by the Expanded Metal Company, as shown in the accompanying illustration. The irregular outline, at the rear, is due to the presence of one of the supporting columns of the building. The door-jambs were made 1 foot 8 inches deep, as shown, in order to accommodate an iron door casing, with double doors inside, which open and fall back against the jamb, and one large outer door. The doorway was roofed over with a slab 3 inches thick, made of concrete and expanded metal. The floor, as well as the roof of the vault, was also made of concrete and expanded metal, the ordinary filling on top of the tile-brick being removed down to the level of the top of the floor girders and its place supplied by the concrete.



Fireproof Vault of Concrete and Expanded Metal

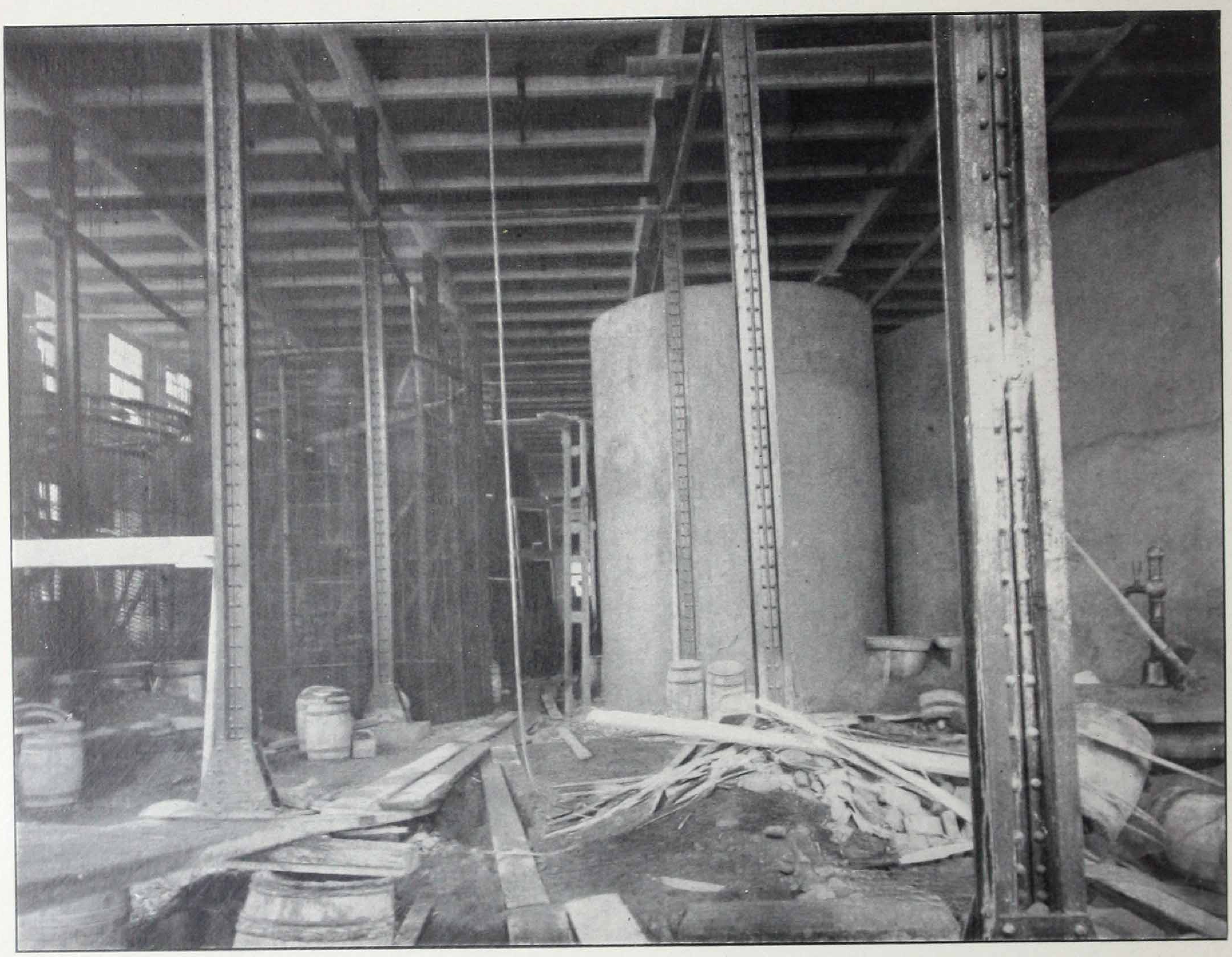
As a sequence to the construction of the vault referred to above there have been numerous similar vaults constructed in various parts of the country. Among others were three built by the Bureau of Public Works, in San Juan, Porto Rico, which are to serve as fireproof vaults for the Treasurer and Auditor of that city.

A vault somewhat similar to the one herewith illustrated was constructed a few months ago for the Union Trust and Storage Company, Washington, D. C., the work being done by the Southern Expanded Metal Company of that city. The entire building in which the vault was constructed had been built on expanded metal system, and the vault itself was made a part of the entire construction. This vault was 9 feet by 17 feet in area. The floor, sidewalls and ceiling were lined with steel plates, making the structure not only fireproof, but practically burglar proof, and is to be the main depository of the safe deposit boxes for the use of the company in question.

The only fireproof planing mill in this country was built, some two years ago, by the John Schneider Lumber Company, in Milwaukee, Wis. The building is 130 feet by 350 feet in size. The floors and roof are constructed of reinforced concrete, and as no shavings or sawdust are allowed to accumulate in the building, the fire risk is very small and the insurance premium is reduced fifty per cent. The dry-kiln of the mill is also fireproofed on the expanded metal system of construction.

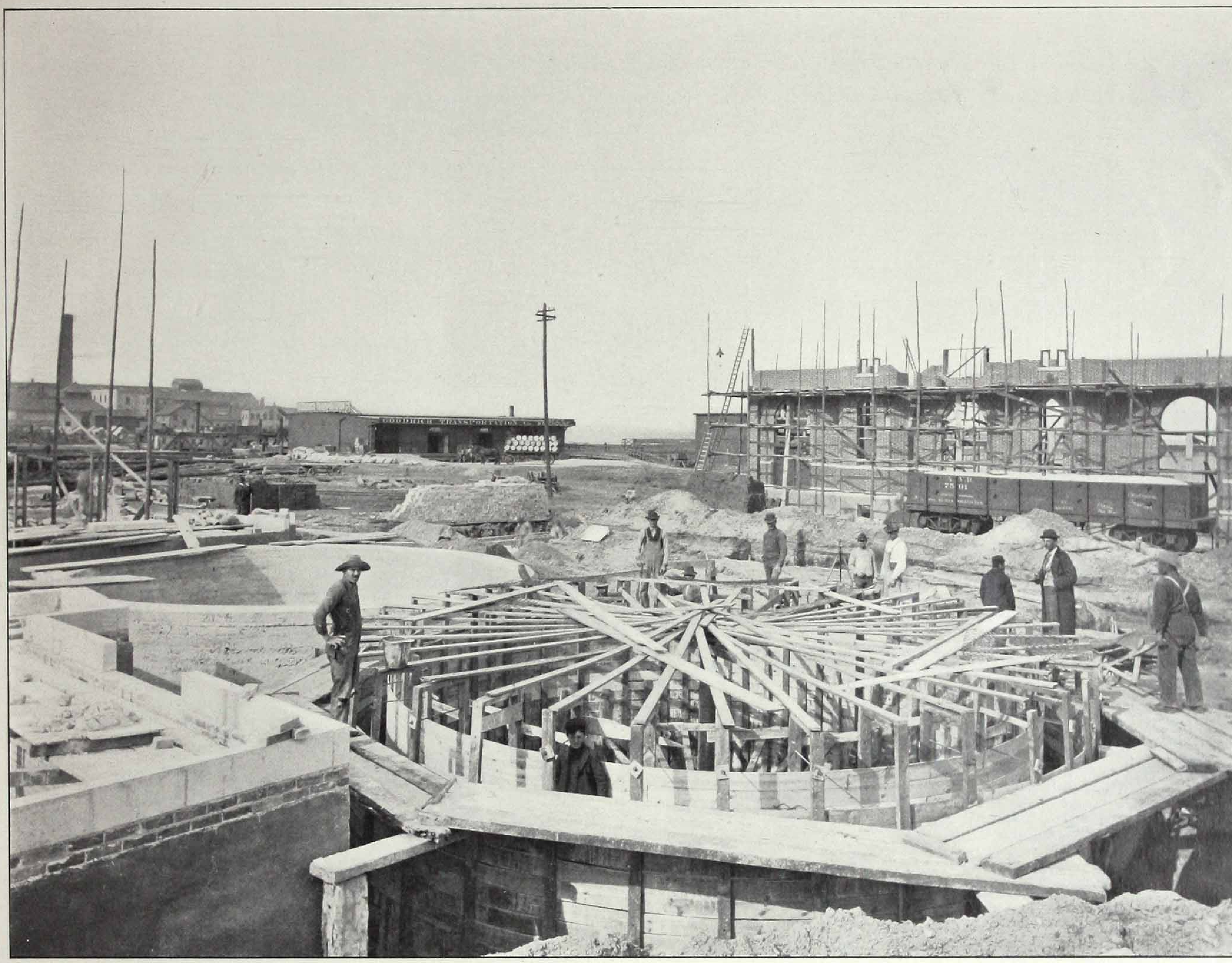
Concrete Tanks

IT is with some degree of justifiable egotism that we announce a perfect accomplishment of concrete and steel tank building. It has been done in a limited way and in small size by others, but the accomplishment from the standpoint of economical construction and desirable and perfect result is another question. In this instance the tanks were wanted for use as bleaching tanks in the Oxford Paper Company's mills,



Expanded Metal Concrete Tanks at Oxford Paper Mills

at Rumford Falls, Me. In all some thirty were erected, averaging 20 feet in height and 14 feet in diameter. In economy it was requisite that they should not cost to exceed those previously built of wood, which, however, were objectionable in that they had a limited lifetime. Designs and details were furnished for this construction by J. H. Wallace, C. E., of New York, and the tanks were built during the past winter and spring. They have proven in every way satisfactory, and as a result orders for still others have been received.



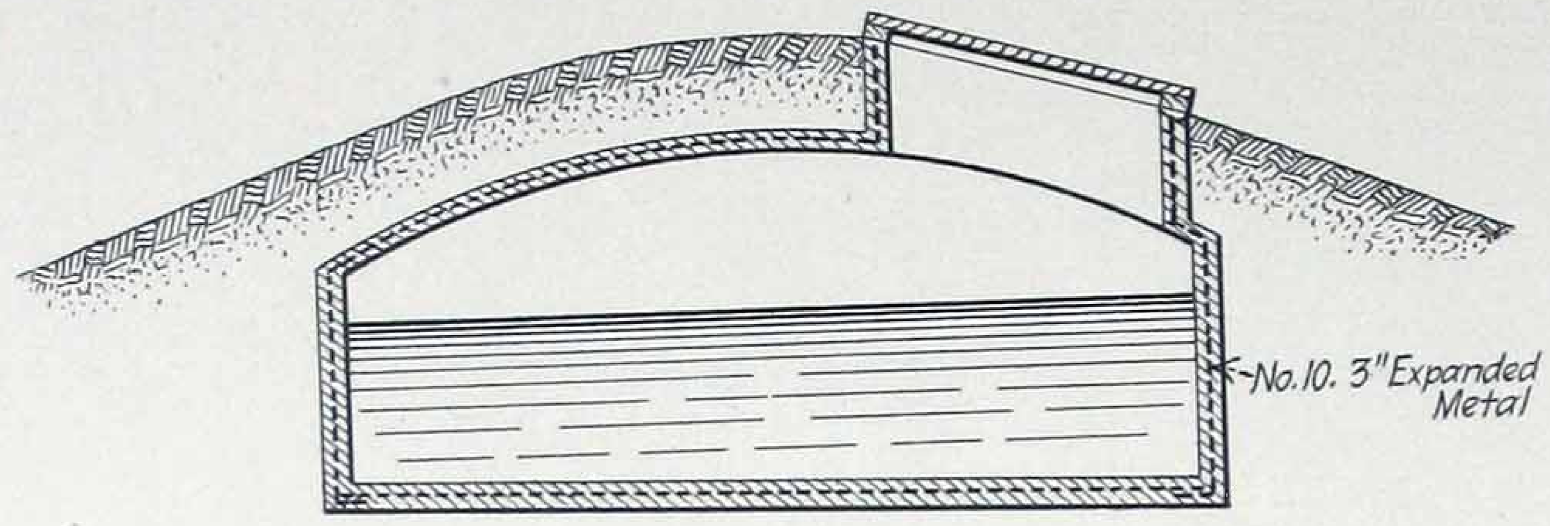
Ammonia Tanks at Gas Works, Racine, Wis.

Ammonia Tanks

AT the local gas works of Racine, Wis., there have been built recently two quite extensive tanks or wells of concrete reinforced with expanded metal. These tanks are for the storage of tar and ammonia extracted from the coal in the process of manufacture of gas. They are each 25 feet in diameter and 9 feet deep. The exterior walls are 17 inches thick at the top, tapering to somewhat larger dimensions at the bottom. The footings of these walls were 12 inches in thickness, which footing rested on gravel foundations. The tanks are each covered with a concrete slab containing expanded metal, and resting upon I-beams bearing upon the outer walls. The expanded metal in the walls was placed close to the outer side of same. The resistance calculated was 500 pounds per square foot. The concrete used was one part cement, two parts sand and five parts of broken stone. The tanks have been in use for several months, and have answered every requirement without damage or harm.

A Small Supply Cistern

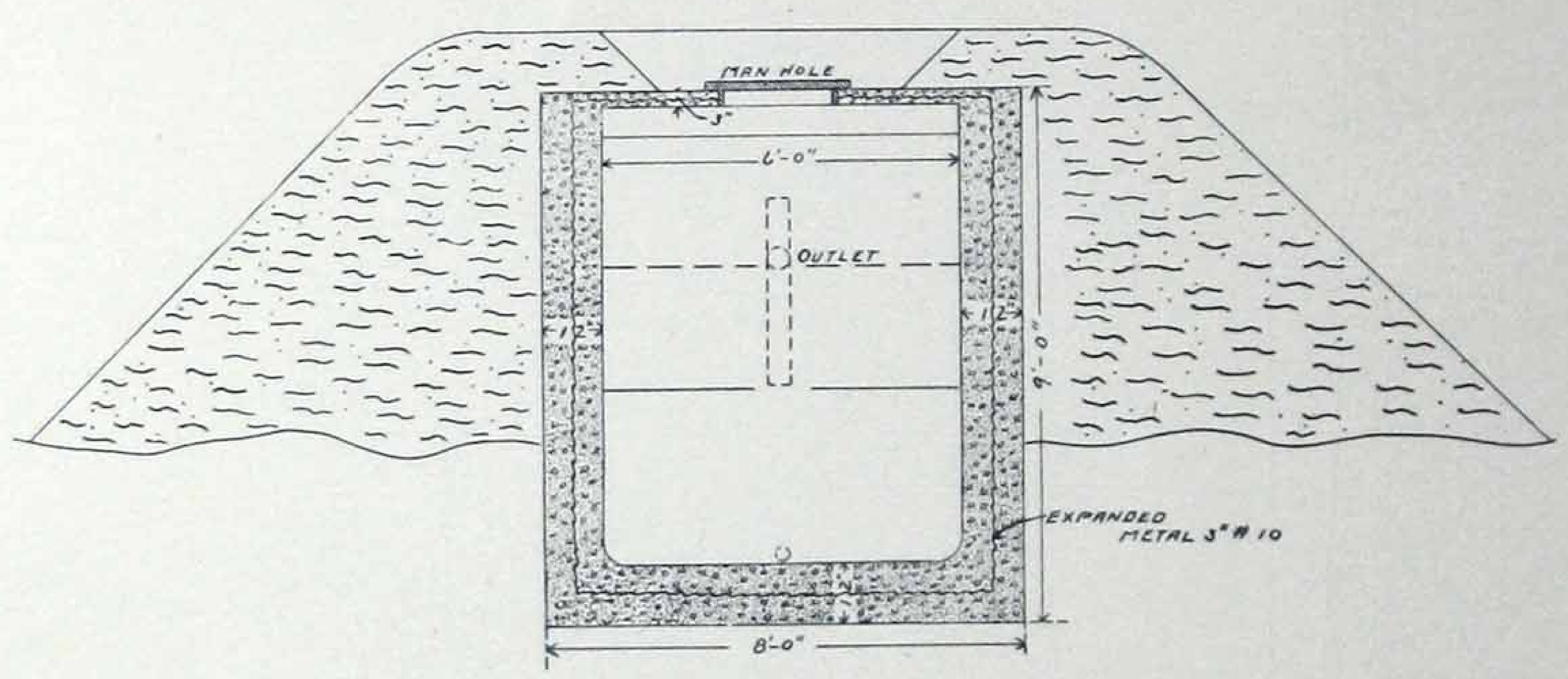
DURING the preliminary stages of the erection of a series of buildings for the Tome Institute, at Port Deposit, Md., a small cistern or reservoir for temporary water supply was required. The hydraulic and sanitary engineer in charge for the institute was Mr. James H. Fuertes, of New York. He designed a reservoir which was constructed in the manner indicated by the accompanying sectional illustration. The cistern was circular, being 16 feet in diameter and 4 feet in depth, and the sides were 6 inches thick, and the roof, which had a rise of 2 feet, was a spherical dome, 4 inches thick at the crown and 5 inches at the edges. This simple little reservoir is an illustration of what may be accomplished for many similar purposes.



Cistern at Port Deposit, Md.

A Septic Tank

THE accompanying illustration is a cross section of a septic tank recently built for the Onteora Club, at Tannersville, N. Y. The tank in question is 30 feet long and 9 feet deep, by 6 feet wide. The walls of the tank are 12 inches thick, being reinforced with a layer of 3-inch No. 10 expanded metal around the sides and top. It was built upon practically level ground, and afterwards an earthen embankment built around it. The work was executed after designs made by Francis L. Pruyn, C. E., of New York city.



Septic Tank at Tannersville, N. Y.

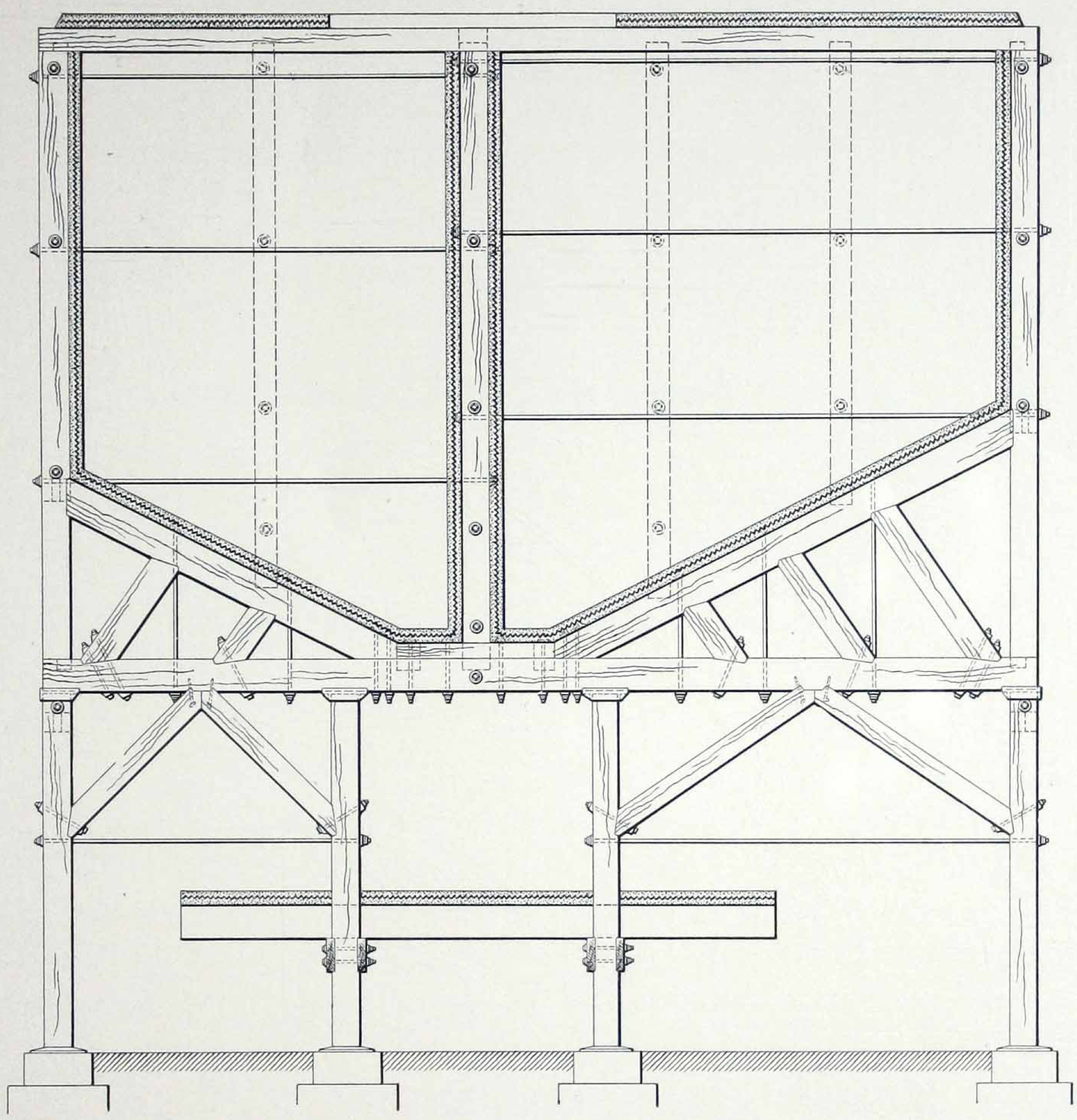
It has been demonstrated in various parts of the country that the question of sidewalks was much simplified by the introduction of expanded metal into a concrete slab carrying the wearing surface. Several different methods were employed to avoid the effects of the frost, and economy was accomplished as well as desirable results.

Tanks similar to those constructed for the Oxford Paper Mills, at Rumford Falls, Me., have been constructed for the Diamond Match Co., at their factory at Southford, Conn. In their factory they are known as "stuff chests." Six of these have been built 10 feet in diameter and 10 feet in height. The work of construction was performed by E. R. Driscoll, Springfield, Mass.

There is no subject in the science of building operations to-day receiving more attention than that of the combination of steel and concrete. At the last annual meeting of the American Society of Civil Engineers there were no less than four papers read and an entire day's discussion. All engineers who are progressive are willing to recognize the value of the combination, and are furthering the subject by giving opportunity for the demonstration of what may be done along this new line of practice.

Cement Bins

IN the reconstruction a year ago of the Glens Falls Portland Cement Company's plant, at Glens Falls, N. Y., which had previously been burned by fire, the entire plant was built on concrete fireproof lines. The result is a new plant with a capacity exceeding one thousand barrels a day. The floors of the series of buildings constituting the plant exceed 100,000 square feet of area, which are built on the expanded metal system. The material was used in



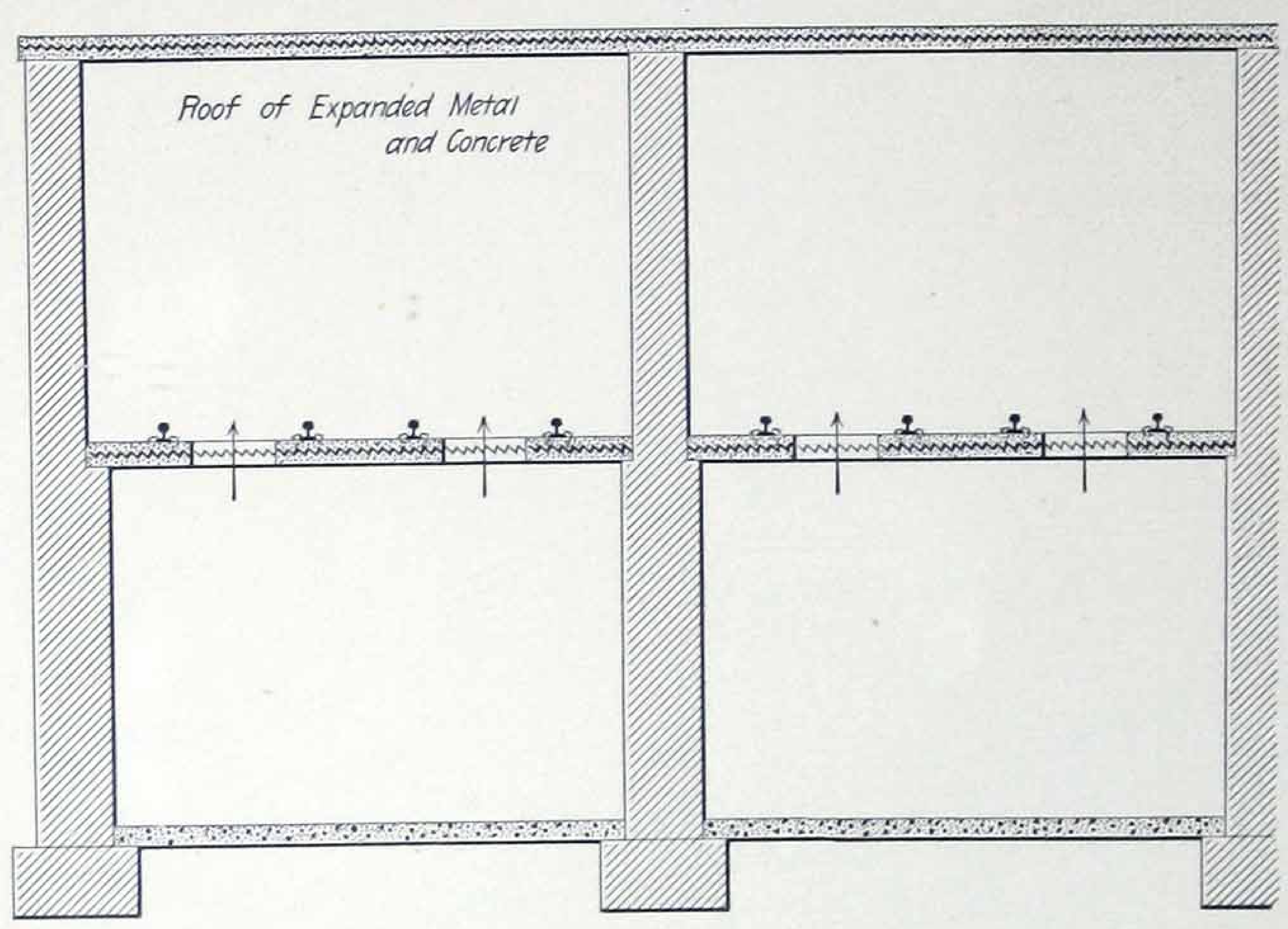
Cement Bins at Glens Falls, N. Y.

various parts of the building in addition to floors. Among other things there was built a dozen or more mixing and storage bins. We show in the accompanying illustration cross section of one of the bins. The details are simple. The general framework was built of heavy wooden timber, firmly bolted together, and the bottom, sides and top were covered with a reinforced slab, the interior surface being neatly troweled with cement.

A recent development is the application of expanded metal lath with a system of light iron framing upon which, as a supporting fabric, are built the walls for hot-air conduits in large power plants. The prevailing method of building these conduits has been by the use of heavy sheet iron. It was found, however, that the heavy iron conduits lost much of their efficiency by the radiation of the heat. The steel and concrete scheme proves to be quite as economic in construction as the former, as well as having many other points of advantage.

Brick Dry Kilns

A VALUABLE consideration in the erection of a brick-drying house is the floor and roof of the hot-air chamber. In recent years it has been a problem of difficult solution to accomplish the desired results. By the combination of expanded metal and concrete the difficulties have been largely overcome. As is understood, these drying houses are long, narrow rooms through which cars of green brick, whether for cement making or commercial purposes, are sent on iron cars, in order that they be thoroughly dried before the next step is taken in the progress of their manufacture. The accompanying illustration shows how simply this has been accomplished by the use of materials admirably adapted for the purpose. The floors on which the cars travel are built of a slab of



Brick Drying Kilns

concrete, with holes at periodical points through which the hot air is forced from the lower chamber. The illustration shown is a cross section from one of these tunnels built a year ago at the works of the Glens Falls Portland Cement Company, at Glens Falls, N. Y. In the works nine of these tunnels were actually built of a length of 100 feet each, having a capacity of 134 cars of green brick. The hot air from the boiler furnaces is drawn by powerful fans through a hot-air duct underneath the ground, built on a similar principle to the tunnel itself. Having entered the drying chamber the hot air rises through the openings directly against the cars of green brick, which are traveling by gravity from the upper to the lower end of the tunnels. The same construction has been used in several similar plants in various parts of the country.

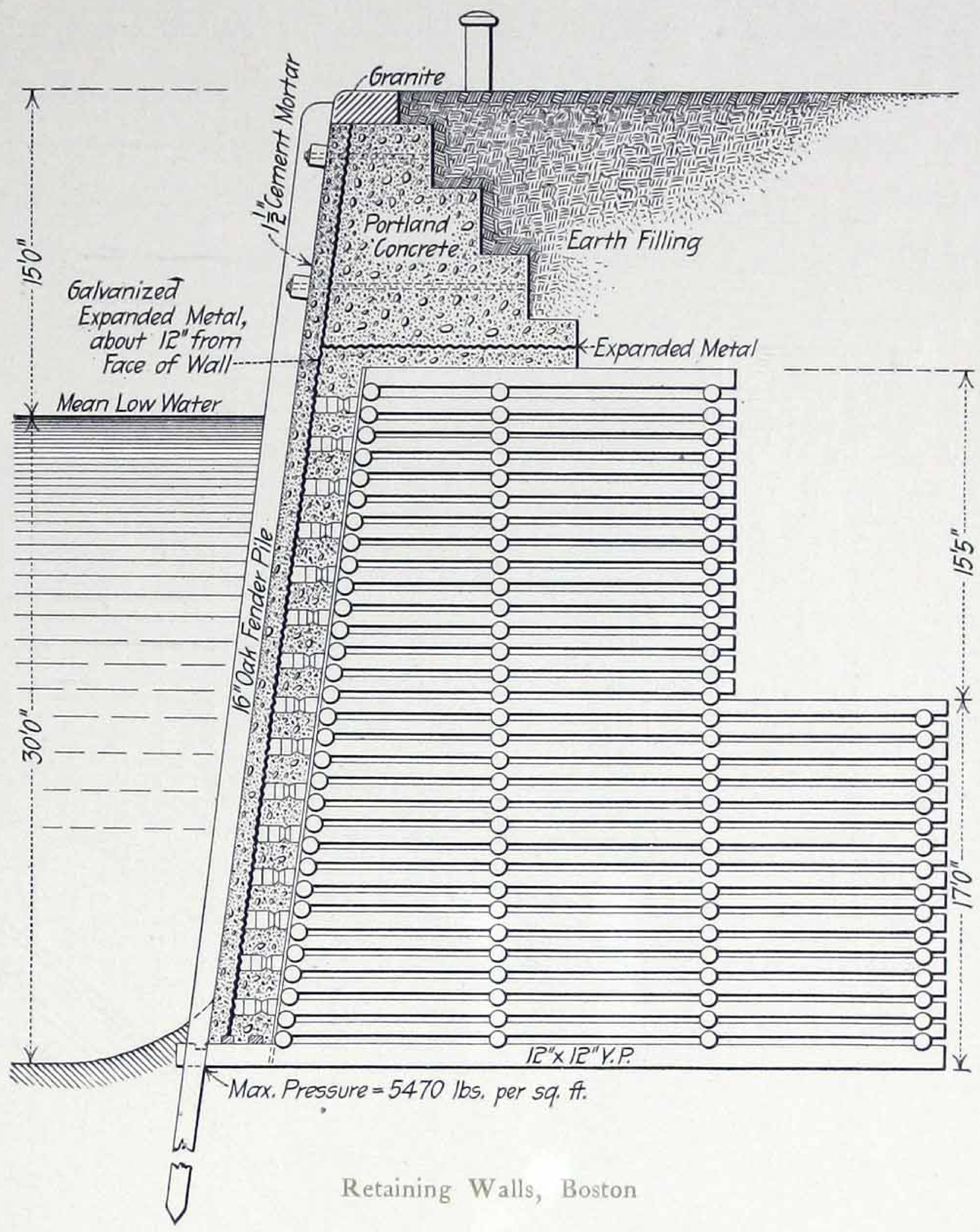
The use of expanded metal for foundation purposes has been taken up by many engineers in this country, as well as in England. In the latter country it has been used very extensively in the foundations of the Morcambe Tower and the Edinburgh Gas Works, and also for the East London Waterworks.

An improvement in deck-house construction has been accomplished by the adoption of expanded metal and concrete in lieu of the ordinary type of terra-cotta walls. In a recent instance, in the city of Baltimore, this was done by building the side walls of the deck house upon our standard type of 2-inch wall construction, the exterior being finished in cement mortar treated with pebble dash. The skeleton frame of the deck-house consisted of 4-inch angle iron uprights and 4-inch angle iron top frame as well, upon which was built a roof of concrete, making the whole house a monolith of steel and concrete.

Concrete Retaining Walls

THE accompanying illustration scarcely needs any description. It is that of a concrete retaining wall in Boston, Mass., wherein a stone-filled crib is faced with a heavy mass of concrete, whose surface is bonded together by the use of expanded metal. This work was done by the Fitchburg Railroad Company on plans approved by the United States Government at Charlestown Navy Yard. The major portion of the work was erected a year or more ago, and it proved so satisfactory that there is now in progress still more of the same class of construction. In the building of this dock wooden cribs were built on land and floated out and sunk at the spot where they were to form the dock. A double line of wooden sheathing surrounded the cribwork, and there was placed in the middle of the space thus formed a series of sheets of expanded metal, 6-inch mesh No. 4 galvanized.

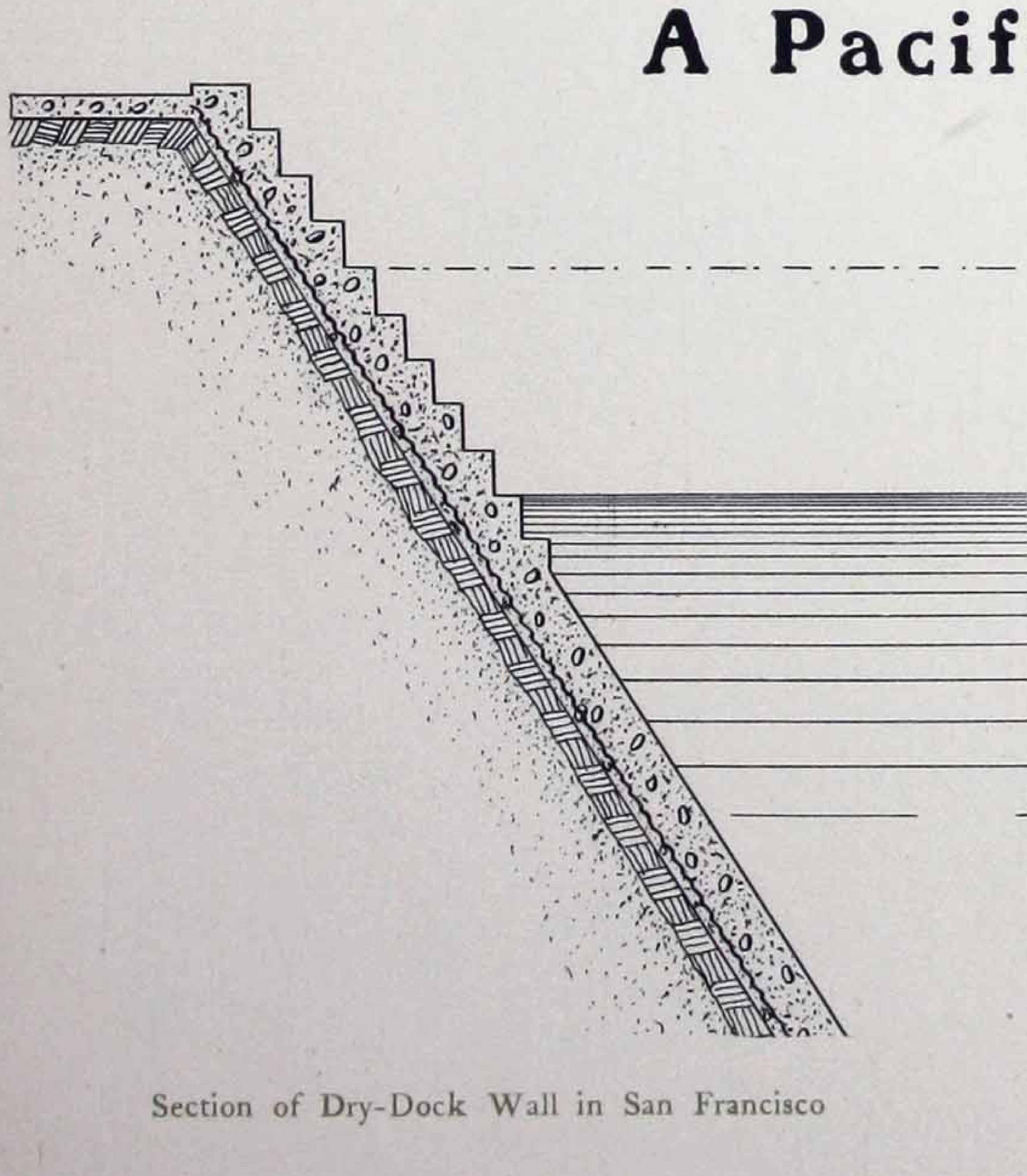
This was then built into place in the sand, and 2 inches of concrete surrounded the entire crib-work. In all, about 50,000 square feet of expanded metal was used in this enterprise.



Retaining Walls, Boston

In the erection of a coal storage plant for the United States Government at Bar Harbor, Me., the contractors, Messrs. Snare & Triest, of New York City, have devised a system of protecting the wooden piles by the use of expanded metal and concrete. We will show in some future issue of THE DOINGS full details of this construction.

A Pacific Coast Dry Dock


Section of Dry-Dock Wall in San Francisco

A certain advantage to the dry-dock facilities of the Pacific Coast has been accomplished by the San Francisco Dry-Dock Company at its yards, Hunters Point, Cal. The plans for this dock were prepared by Howard C. Holmes, Chief Engineer State Harbor Commissioners, San Francisco. In the construction of this dock the entire chamber has been concrete lined, reinforced with expanded metal, except for the sides of the approach, seat for the caisson and the apron arch, which are of cut granite masonry. The illustration accompanying this shows a small section of the side of the dock, and indicates the manner in which the expanded metal was used to bond the concrete sides. It might be mentioned that between the concrete lining and the rock surface a thorough coating of damp-proofing was used.

Power Plants

SO much work and covering so wide a range has been accomplished in the use of expanded metal and concrete for power plants that it is difficult to select typical samples under this heading. We have built in various parts of the country, literally, every feature and part of power-plant buildings by the combination of concrete and expanded metal. In some instances these materials have been used in the foundations, side walls and roofs and division walls of the buildings along lines which may be readily understood. It is manifest, of course, that in power plants it is

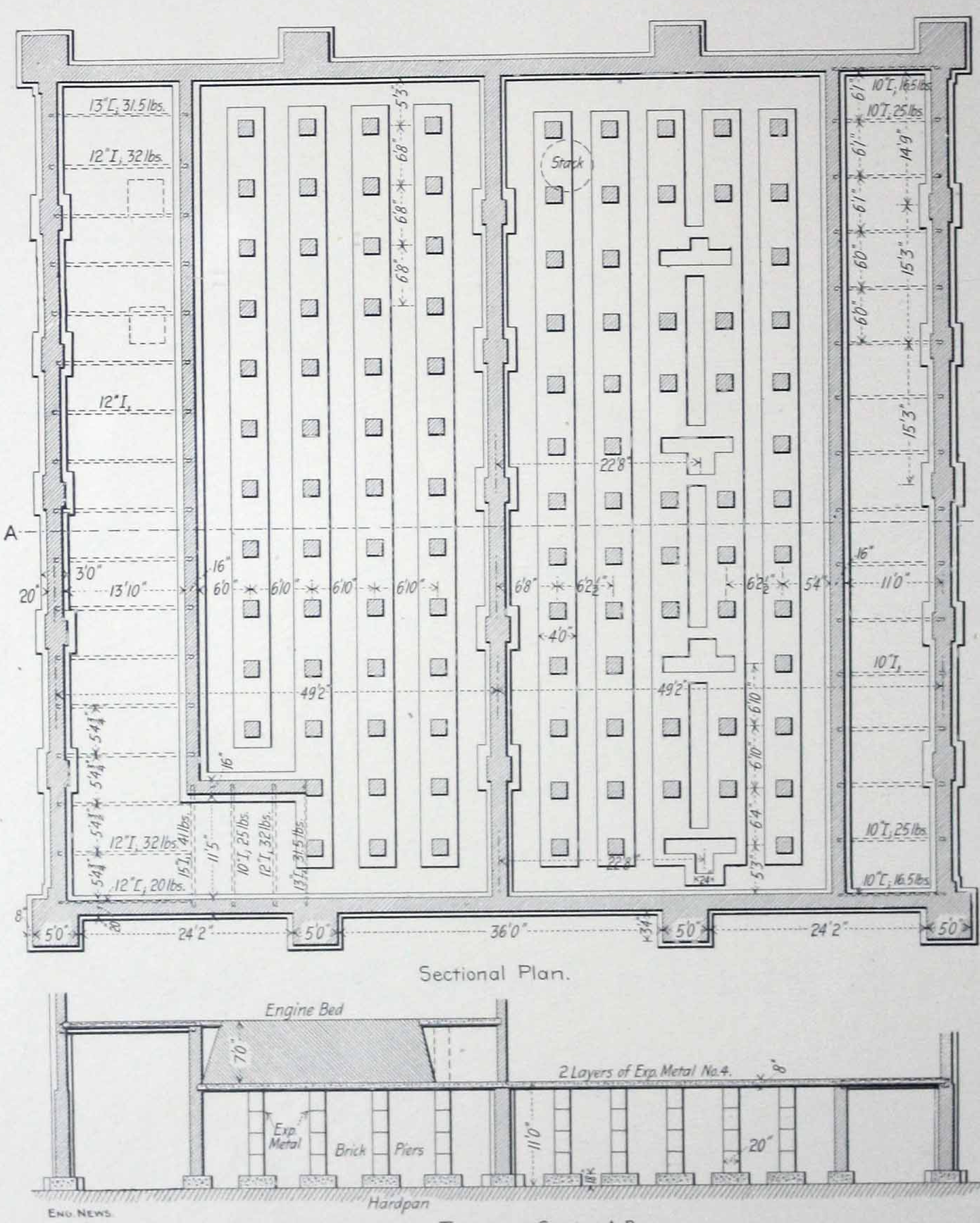


Fig. 1. Expanded Metal-Concrete Floors in Power House, Far Rockaway, N. Y.

essential that the construction be of the most substantial and permanent character. It is, therefore, with much pride that we can point to many instances wherein expanded metal and concrete have been used for this class of construction in various parts of the country, and in structures which are the highest type of their class.

We show in the accompanying illustration a transverse section of a large power plant erected a couple of years ago at Far Rockaway, a village which is now a part of Greater New York, which represents the power plant of

the Queens Borough Electric Light and Power Company, and was designed and erected by the well-known engineering firm of Sanderson & Porter, New York City.

The most notable feature in the construction of this plant is the type of foundations and floors used. The building is located close to the bulkhead of the salt-water inlet, in order that coal may be taken directly from vessels and sea water used for condensing.

The ground here offered a very poor base for foundations, and it was necessary to excavate to a depth of 10 feet or more to hardpan. Upon this concrete bases were laid, 4 feet wide, 18 inches in depth, and running the entire length of the building. These bases are spaced 6 to 7 feet from center to center. A sectional plan and elevation of

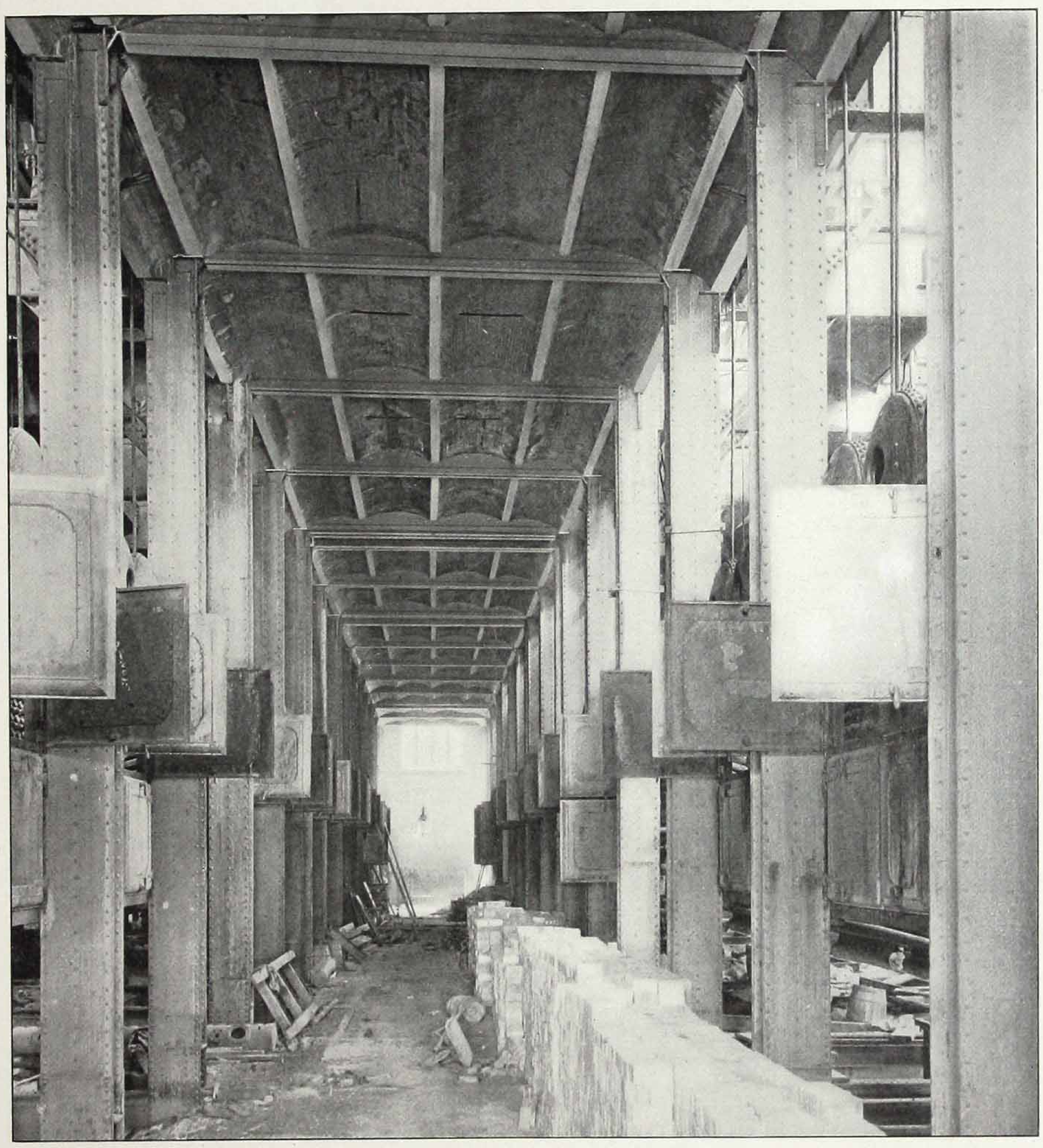


Fig. 2. Floor Construction in New York Edison Company's Power House

the foundation and floors is given in Fig. 1. Upon these strips of concrete, brick piers 20 inches square were built, spaced about 6 feet apart, and rising to within 8 inches of the level of the boiler-house floor. A false floor was then built flush with the tops of the piers and over the whole was spread a 2-inch layer of concrete.

While still soft this was covered with a layer of expanded metal, and then by another layer of concrete. Upon this was placed a second layer of expanded metal, and then the addition of 4 inches more of concrete completed the floor. As will be obvious, the expanded metal is intended to furnish the necessary tensile strength for the under side of the floor. It is possible that the floor would be still stronger if a layer of expanded metal had also been placed near the upper surface, as the floor is subjected to considerable negative bending moments at points over the piers. It

may be noted that expanded metal was used instead of bonding stones in the construction of the piers themselves, and that the floor was thoroughly bonded into the walls of the building.

The first floor, which we have just described, serves in that part of the building shown on the right-hand side of the plan as the boiler-room floor, and is 2 feet above high-tide level. In the left-hand side of the building this floor was used as a base upon which to build the engine foundations, and also as a support for another set of brick piers which carry the engine-room floor, built in the same manner as the lower floor, and level with the tops of the engine foundations into which it is bonded.

As first designed, these floors were to be supported by heavy brick arches, which would have entailed great expense, both because of the more expensive materials employed and the great amount and higher price of the labor required. The present floor has proven satisfactory in every way and shows no tendency to crack or crush, even when subjected to severe strains by the moving of heavy machinery about upon it.

This is an illustration of the rapid change going on all over the country in modes of construction by first-class engineers. The monolithic idea, as represented by masses of concrete strengthened and tied together by steel in its most desirable form, is fast asserting itself in many directions.

The Largest Power House in the World

We show, in Fig. 2, an illustration made from a photograph of the partially completed boiler room of the New York Edison Company's power house, known as the Waterside Station, now being completed at Thirty-eighth and Thirty-ninth Streets and the East River, New York City. This is the largest steam power house in the United States. The total dimensions of the building are 272 feet by 197 feet, and equivalent to six stories in height. The building has been more than one year in the course of erection, and will take months yet before it is entirely completed. When ready for final operation it will have 96,000 normal horse power, with a maximum of 128,000 horse power, making it, as stated above, the largest steam power plant in the country. The illustration is made through the center of one of the two stories of boiler rooms, and the floors throughout these two rooms are expanded metal construction, besides all of the floors of the various engine rooms and the entire roof of the structure. The engineer for this enterprise was Mr. John Van Vleck, and Mr. Chas. F. Hoppe, architect.

A series of ornamental expanded metal-concrete bridges are being built on the country estate of Mr. Henry Seigel at Mamaroneck, N. Y., which were designed and constructed by Tucker & Vinton, engineers and contractors. Others of similar type are being built by the Abbot-Gamble Construction Company on the country place of Mr. Howard Gould, near Port Washington, Long Island.

A year ago in Boston expanded metal was used very largely in the construction of public baths at Revere Beach, where it was used in floors, roofs, walls, etc., and it is now being specified for several large free baths in New York City.

Hydraulic Power House

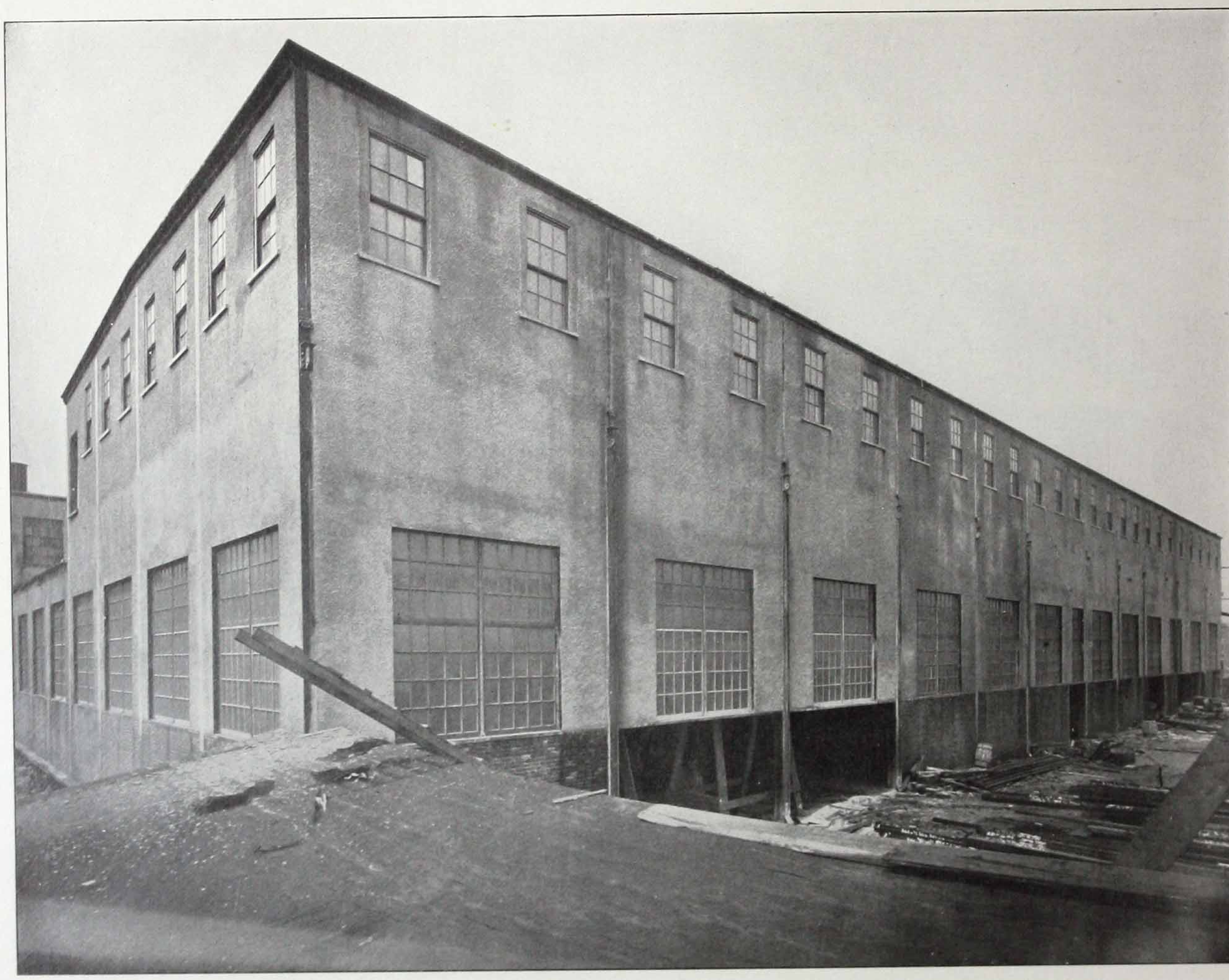
DURING the past year or two the development of extensive water-power plants has become an interesting feature in the engineering progress of Canada. Owing to the severity of the climate it has been a serious problem to construct all parts of buildings and their fixtures in connection with same, to secure the best results. After careful examination among engineers they adopted the expanded metal system in connection with such buildings quite extensively, especially in connection with the erection of power houses. This applies to the floors and roofs, and to the walls as well. The accompanying illustration shows the skeleton frame in steel of a wheel-house building for the Capitol Power Company near Ottawa, Ont. This building is 130 feet in length, and is erected over a series of water-wheel pits, all of which are constructed of concrete. The picture shows very clearly the method of construction of the outer walls of the building. As described in previous issues of THE DOINGS, the studding members of the wall are placed in position in the ordinary way, and to this is attached the lath, which, in this case, was our standard diamond mesh lath, studding consisting of 3/4-inch channel-steel forms set at 12-inch centers. The walls are 15 feet in height. A 2-inch by 2-inch angle iron forms a horizontal purline, and carries the window frames where such occur. The walls are plastered 2 inches thick with Portland cement and asbestic mortar, the outer surface being pointed off to represent stone.

It was discovered that the cost of these walls was fully twenty per cent. less than if they had been of brick, and took much less time in construction, and besides the weight of the walls on their foundations was scarcely twenty-five per cent. of what the brick walls would have weighed. The Expanded Metal Fireproofing Company, Limited, Toronto, executed the contracts for this work, and have also performed other work for power houses and modern buildings at Ottawa, E. B. Eddy Company, Limited, Ottawa Electric Company and the Bronson Carbide Company. These buildings were destroyed by the great fire which swept through there more than a year ago. They have made large use of expanded metal in the construction of their new plants and are now in successful operation.

Hydraulic Power House, Ottawa, Canada

Factory Construction

OUR system of factory construction is fairly well known throughout the United States. It is a simple and short story. The word "factory," as associated in the minds of most persons, is a group of one-story buildings spread over a large area which are usually constructed of brick walls and filled with wooden columns and roofs and window casings painted enough to show color, but all ready to burn. The oil-soaked floors and litter scattered around in all directions make the fire risk one of extreme hazard. During the past few years it has been demonstrated as a fact that a fireproof factory building for the average manufacturing establishment in this country can be constructed at almost the same cost as the old style tinder box. This has been accomplished by very simple methods

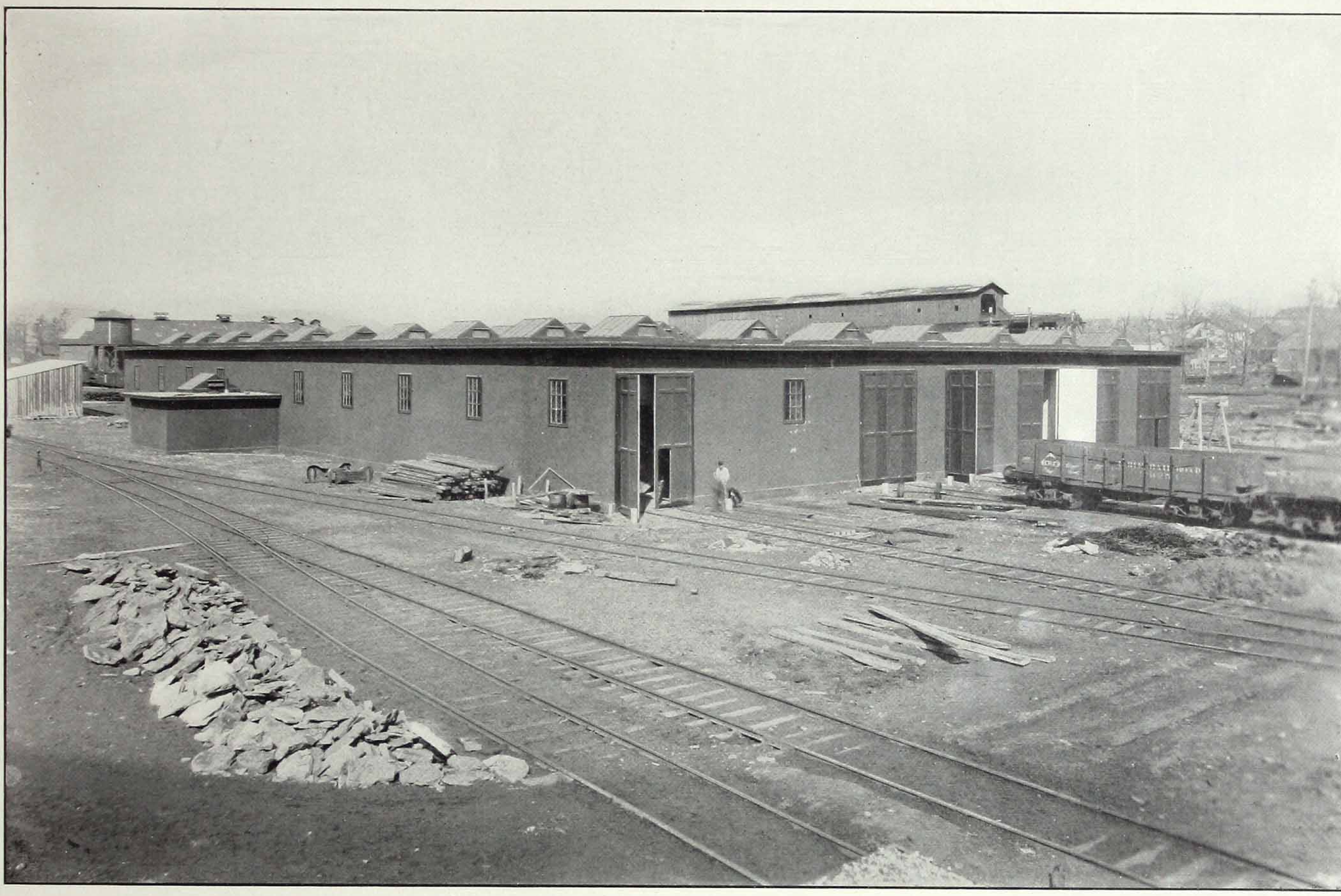


New Shops of Boston Bridge Works

after all. By using iron columns placed on reinforced slabs of concrete for foundations and the employment of good engineering skill, it is possible now to erect a factory building with plenty of light in the side walls as well as in the roof, and with a maximum amount of advantage in all directions. The best form of side walls for buildings of this general class may be described as the monolithic wall of steel and cement mortar. The steel should consist of small members, such as $\frac{3}{4}$-inch flat-iron bars, placed at 12-inch to 16-inch centers, upon which is laced a fabric of expanded metal lath, and upon this is built, with the plasterer's trowel, a slab of 2 inches to 3 inches in thickness. The roofs should be erected of steel framing and should carry a slab of reinforced concrete on various spans

according to the general design, these spans ranging from 5 feet to 20 feet. If the roofs be flat enough ordinary tar and gravel are quite desirable, or if steep roofs are wanted, slate may be nailed directly to the concrete. This general description is quite sufficient for the instruction of the average engineer, barring such details as may be inquired for.

Upon this system there have been erected entire factory plants, ranging from one to half a dozen or more buildings in various parts of the country.



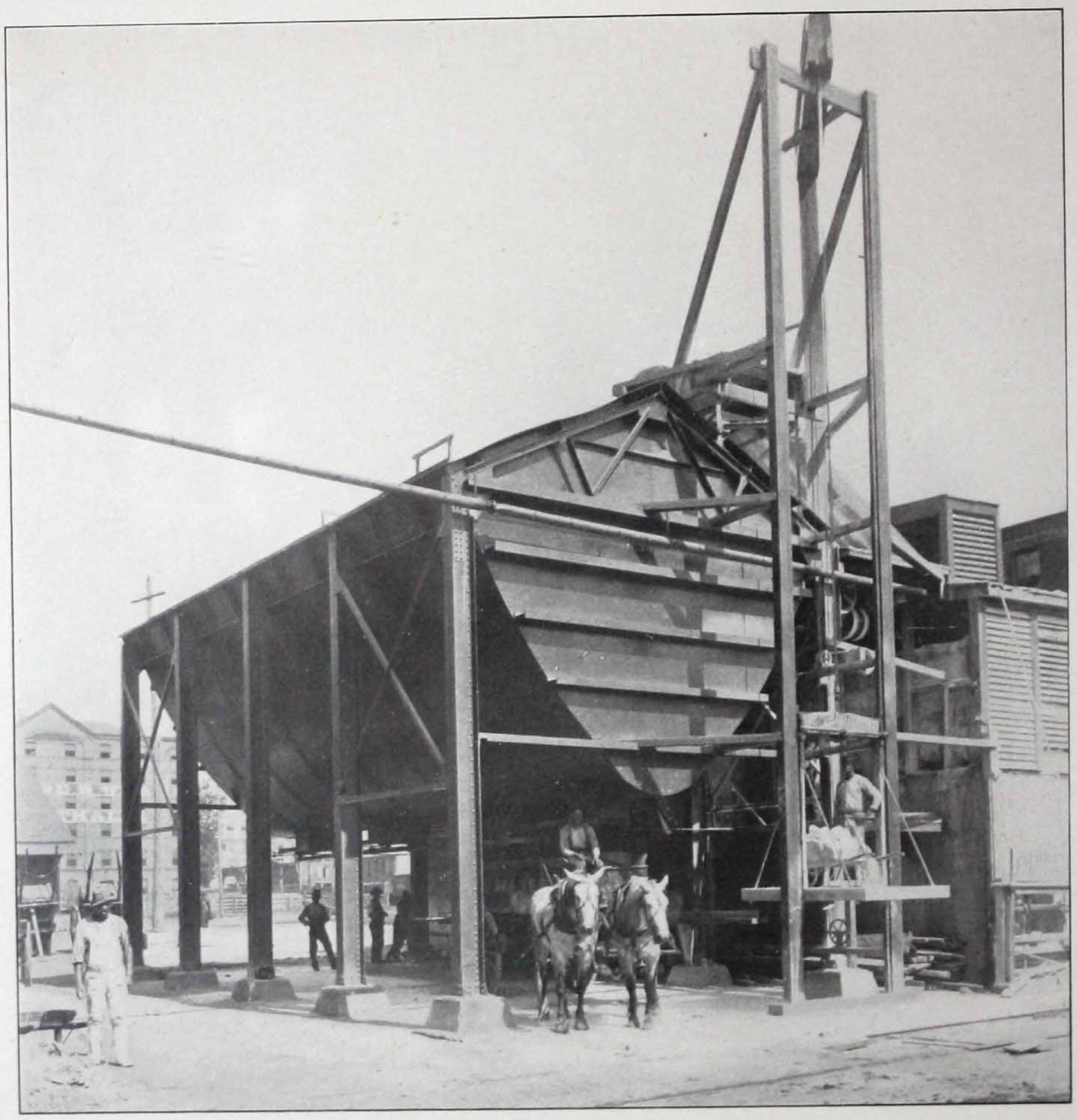
Car Repair Shop, Dunmore Iron and Steel Company, Dunmore, Pa.

The first extensive plant built on this system was the Walker Soap Company's factory at Pittsburgh, Pa. We show in this connection a view of one of the buildings constructed a year ago for the Dunmore Iron and Steel Company, at Dunmore, Pa., by Mr. Geo. Hill, engineer and contractor. Mr. Hill is now erecting a still more extensive set of shops at Elizabethport, N. J., for the Central Railroad of New Jersey. In each of these plants there was consumed more than 250,000 square feet of expanded metal. We also show an illustration of a recently completed building for the Boston Bridge Works, in Boston, Mass.

Similar buildings have been erected for Morse & Whyte, of Boston, besides many small factory buildings in various parts of the country.

Lime Bunker

THE accompanying illustration is that of a lime bunker recently erected for the Chas. Warner Company in Wilmington, Del. It is built after the design and details known as the Berquist Suspended Bunker System, of which Mr. A. S. Berquist, of Brooklyn, N. Y., is the inventor. The novel and peculiar feature of this bin is the lining of same. It is well known that lime will slack in the air and become unfit for use even if it is stored for only a short time. To obviate this deterioration it is necessary to store lime in closely-fitting barrels, and this is the usual practice. To this there is the objection of expense in labor, and besides the great care necessary to store and protect



the barrels. In this instance the job was to put a lining in the bin or bunker which would be air and moisture tight. This was accomplished by means of lining the steel bunker with concrete reinforced with expanded metal.

The bunker holds 4,000 tons of lime, and has been in use for some months, and the results so far have been entirely satisfactory. The steel work for the bunker was constructed by the American Bridge Company, and the concrete lining by Merritt & Co., Philadelphia.

Mr. Berquist has built a number of coal bunkers in various parts of the country on the same system.

Tests

WE are constantly in receipt of inquiries as to tests of our construction in its many forms. These inquiries bear especially upon floor construction. So many tests have been made and under so many different conditions, that it is difficult to classify them to answer any specific inquiry.

Some three years ago a series of tests were made covering the entire question of beams or slabs, the results of which were published in the Transactions of the American Society of Civil Engineers, in June, 1898, being issue No. 831. The report of these tests was full and exhausting. We have made many tests of floors in actual position. Some of these were made in a manner wherefrom specific data could be obtained, and to which reference can be made.

Some two years ago, in the construction of a large factory building for the Larkin Soap Company, at Buffalo, a very thorough and complete test was made by Robert J. Reidpath, the engineer who designed and constructed the building. In that test a floor slab, 3 inches thick and 4 feet 10 inches in span by 13 feet 10 inches in length between girders, carried a uniformly distributed load of 2,333 pounds per square foot. This load did not result in injury to the floor, and then it was put under test by concentrated load covering an area of 12 inches in width and the full length of the slab. This was then loaded with pig iron up to 4,855 pounds, resulting in the breakage of the slab.

A more recent instance of an authentic test was made in the new power house for the New York Edison Company at the Waterside Station, New York City. This test was upon a segment arch construction, 5 feet in span, 5 inches thick at the crown, the arch being 5 feet in length. The arch was built on 15-inch beams with a 10-inch rise. This was tested by a hydraulic machine applying the load upon a plank 12 inches in length lying midway between the beams. A pressure of 125,000 pounds was applied to the arch, but owing to the breakage of a part of the machine, the test was stopped without anything more than slight damage to the arch.

As noted above, tests have been made under many conditions and in many locations. We refer to some very exhaustive tests some years ago made by Sir John Fowler and Sir Benjamin Baker of London, and we quote a single paragraph from a report made by them:

"The quantity of concrete per square foot, and therefore the weight, in the case of the slabs, is two-thirds of that in the arches of the same span and minimum thickness at the crown and with a rise of one-fourteenth to one-fifteenth of the span. This fact points to the utility of expanded metal in conjunction with concrete in flat slabs as a material for flooring."

In other pages of this publication will be found references to various tests in actual practice of types of construction other than floors. There has been made recently a very thorough and exhaustive test and report upon what may be termed long span construction in Boston. These tests were made not only to determine the weight-carrying capacity of the floors, but the fire-resisting quality of the concrete. We print herewith a report in full made by Prof. C. L. Norton of the Massachusetts Institute of Technology, and also a report made by J. R. Worcester, a well-known engineer of Boston. These reports are addressed to Messrs. Simpson Brothers, contractors, who make a specialty of warehouse construction, and in conjunction with the Eastern Expanded Metal Company built the test-house referred to in the report.

Report of Professor Norton is as follows:

Boston, July 31, 1901.

Messrs. Simpson Brothers, Corporation,
166 Devonshire Street.

Gentlemen—I send you herewith report of the test of the concrete house at Allston, July 10, 1901.

A test was made of the strength and fireproof qualities of an arch consisting of concrete in which there was imbedded expanded metal. The I-beams upon which the arch rested were protected by concrete, and it was also intended to test the measure of the protection which the concrete afforded the steel beams. The arch was 11 feet and 1 inch wide between the centre of the I-beams and 17 feet and 9 inches long. It consisted of a slab of stone concrete 6½ inches thick with 1½ inches of cinder concrete on the under side. Five and one-half inches from the upper face of the arch was a sheet of expanded metal bedded in the stone concrete. This metal was No. 4 gauge with a 6-inch mesh, and the two 8-foot lengths were lapped in the middle of the arch, the metal being double for a width of 5 feet 5 inches. There was also a sheet of expanded metal bent over and behind each I-beam and then down toward the centre of the arch on top of the first sheet. This is shown in the accompanying cross-section. The top of the arch for a depth of 1 inch was composed of a mixture of 1 part cement, 1 part gravel and 1 part broken stone. The stone was sifted through a ½-inch mesh. The next 5½ inches of the slab was composed of a mixture of 1 part cement, 2½ parts gravel and 5 parts stone. The stone was screened through a ⅝-inch mesh. The 1½-inch layer on the under side of the slab was composed of 1 part cement, 2½ parts gravel and 6 parts of cinders. The I-beams were protected by a layer 1½ inches thick of concrete composed of 1 part cement, 2½ parts gravel and 6 parts cinders. The cement used in all the construction was Alpha Portland cement. The beams were plastered to a thickness of about ½ of an inch with a cement composed of Portland cement, lime and sand.

Supporting each I-beam there were three posts made of 8-inch channel iron, which were wrapped about with expanded metal and covered with cinder concrete to the depth of about ¾ of an inch. It was intended to apply this concrete to a depth of 1½ inches, but through some error it was practically all less than 1 inch thick.

The ends of the I-beams received further support by resting upon a concrete wall at each end, and these two concrete walls, with two others at right angles, formed an enclosure underneath and surrounding the arch itself. At one end of the arch there were openings in the wall underneath it, and two chimneys about 20 feet high were located just outside the wall and furnished draught for the fire which was later built underneath the arch. In the end wall farthest from the chimneys there were two doors through which wood might be thrown in, and about one-half of the floor space was covered by a grate of railroad iron. Upon one side there was a small door through which the fire stream might be directed. The side door was bricked up loosely and the end doors were closed by heavy sheet iron plates.

At 2:41 P. M., on July 10, a wood fire was started by means of kindling and kerosene, and before 3 P. M. it had reached a temperature of 500° C. The temperature of the fire then rose as follows:

Average Temperature of Fire

Time	Temperature	Time	Temperature
2:45	600	4:25	890
2:47	670	4:27	935
2:48	685	4:35	890
2:49	715	4:50	805
2:51	680	4:54	855
2:53	665	5:00	810
3:00	820	5:03	885
3:02	670	5:15	890
3:17	715	5:16	930
3:26	740	5:24	980
3:38	745	5:25	995
3:47	760	5:48	685
4:05	770	5:55	770
4:15	835	6:00	840

There were placed in contact with the I-beams a dozen thermal junctions in order to determine the temperature of the metal during the fire. These junctions showed practically the same temperature for the different parts of the I-beams throughout the test, the differences between the junctions being only 10 or 15 degrees. The average temperature of the beams is given below:

Temperature of I-Beams

Time	Temperature Degrees Centigrade
3:05	40
3:20	55
3:40	65
3:54	75
4:00	85
4:10	110
4:55	120
5:10	115
5:45	115

The temperature of the web of one I-beam was also taken, but at no time did it reach 80° C.

In order to withstand the load there were put across from one I-beam to the other 3 tie rods 1 ½ inches in diameter. These were protected during the test by cinder concrete. Their only object was to prevent the I-beams spreading and to furnish to the I-beams a support similar to that which adjacent sections of the floor would furnish to any one section in the building.

After the fire had burned for 2 hours and 26 minutes water was turned in at pressure of 59 pounds through a 1 ⅛-inch nozzle.

The water was directed upon the fire itself for one minute, then upon the ceiling and beams for two minutes. At 5:29 the side door was knocked open and a stream of water was directed upon the ceiling for two minutes. The stream was then returned to the front door for one minute. The water was then shut off.. Immediately a second fire was built, and at 5:40 it was burning briskly. The temperature of this fire has already been given, and the water was applied to extinguish it at 6:12 under pressure of 58 pounds. At 6:15 the water was again thrown in at the ceiling through the side door for 3 minutes, and at 6:20 effort was made to cool down the whole structure.

On the morning before the fire the top of the arch had been loaded with pig iron. The load was first 1,000 pounds per square foot. This resulted in a deflection of the centre of the floor amounting to slightly less than $\frac{1}{16}$ of an inch. The load was then reduced to 400 pounds per square foot, when the floor returned to its original position within a very small amount, certainly less than $\frac{1}{32}$ of an inch. This was at 2:41, immediately before the fire. During the fire the floor sagged, the depressions being as follows:

Time	Deflection
2:41	.03 inches
3:13	.20 "
3:33	.25 "
3:45	.37 "
5:40	.90 "

During the night after the fire test just noted, the wood which was left in the house again caught fire and burned until 8 or 9 o'clock the next morning. The exact duration of this fire cannot be known, but the heating of the outside of the structure and the amount of water necessary to cool it down would indicate that it was fully as severe as the first fire. After this third fire the structure recovered somewhat, the deflection being reduced to .80 of an inch.

The load was then increased until it amounted to 1,824 pounds per square foot. This increased the deflection to 2¼ inches at the centre of the floor. The load was allowed to remain on the arch for five days, it having been reduced to 1,650 pounds per square foot. After unloading, the deflection of the floor decreased to 1.80 inch.

An examination of the arch after it was unloaded showed many fine cracks on top extending across the corners forming portions of ellipses. The whole granolithic top was slightly checked with fine cracks of slight depth ; there was no shearing of the concrete from the I-beams and no longitudinal cracks across the arch. The underside of the floor shows several small patches of cinder concrete gone. In only one case has the cinder layer split away from the stone concrete, and in only one place is the expanded metal exposed. This is where the sheets lapped and one sheet is bent down below the normal position. There are radial cracks on the underside of the slab coming from each corner ; some of these are not deep enough to enter the stone concrete. There is one which has entered the stone concrete a little to one side of the middle of the house toward the east. The cracks upon the top and upon the bottom of the slab are at right angles to one another.

The condition of the beam covering after the first fire was good excepting upon one point of the flange. The protection of the posts was insufficient in thickness and some of it was wholly destroyed by the stream after the first fire. The temperature of the beams shows that 1½-inch cinder concrete protection is sufficient to withstand the test here given.

The arch as it now stands is practically intact and would undoubtedly carry its full load of 1,600 pounds per square foot. The amount of the deflection is considerably greater than it would have been had not the third fire occurred. There are no cracks which indicate an impending rupture of the slab, and such damage as has been done might readily be repaired. The post covering is insufficient. The beam covering is ample.

Respectfully submitted,

C. L. Norton.

The report of Mr. Worcester is in full as follows:

Boston, July 24, 1901.

Simpson Brothers, Corporation,
166 Devonshire Street.

Gentlemen—At your request, I have to-day examined the section of expanded metal-concrete flooring, erected for test purposes at Beacon Park, with a view of reporting as to its present condition.

Without entering into a detailed description of the method of construction, which I presume you have, I would say that I find the ceiling underneath the floor to be intact, with the following exceptions: In four places where I am informed the water from the hose used in quenching the fire was projected against it, a layer of the cinder concrete about 1 inch in thickness has fallen off. These patches vary in size from about 15 x 10 inches to 36 x 16 inches. They are irregular in shape, and in some places around the edge look as though there was a horizontal separation between the lower layer of the concrete and that above it, extending in a short distance from the part that is detached. It does not appear, however, that this plane of cleavage corresponds to the division between the cinder concrete and the stone concrete, but rather to be within the depth of the cinder material.

Beside these patches where the finish has fallen off there are a number of cracks, mostly extending in diagonally from the corners of the building. These cracks do not appear in any case to extend in for a greater depth than 1 or 1½ inches. Examining closely the concrete exposed in the patches where the outside has fallen off, I find in one or two instances fine cracks running at right angles to the sheets of expanded metal or parallel to the 20-inch beams. These cracks are very fine and probably not over 1 inch or so in depth. In one of the patches one strand of the expanded metal is exposed for a distance of 1 or 2 inches, and at this point there appears to be a second horizontal cleavage started, about at the level of the expanded metal sheet. This, however, is not very plain.

The fireproofing of the columns seems to have been sufficient to prevent the heat injuring the metal of the same, but in one instance the plastering has entirely dropped off from the expanded metal on one side, and as this side had little or no cinder concrete between the lathing and the column, the flange of the same is exposed. On another column a part of the plastering has entirely dropped off and exposed the expanded metal but not the column. Apparently the columns were not protected by a sufficient amount of concrete to resist the fire and water to which they have been subjected.

The top of the floor shows a series of small cracks in the granolithic, running approximately parallel to the edges of the square and cutting off the corners, in other words, about at right angles to those seen in the ceiling below. The floor is now deflected about 2 inches at the centre ; otherwise it appears to be all right.

Judging from the appearance of the floor as it stands, the deflection and the cracks were wholly caused by the intense heat on the bottom surface while the load was superimposed. I should not imagine that the concrete or expanded metal is seriously injured so far as strength is concerned, and I see no reason to suppose that the floor would not now carry as much load as it has at any time.

If a more detailed report would be of any interest to you, please let me know.

Yours truly,

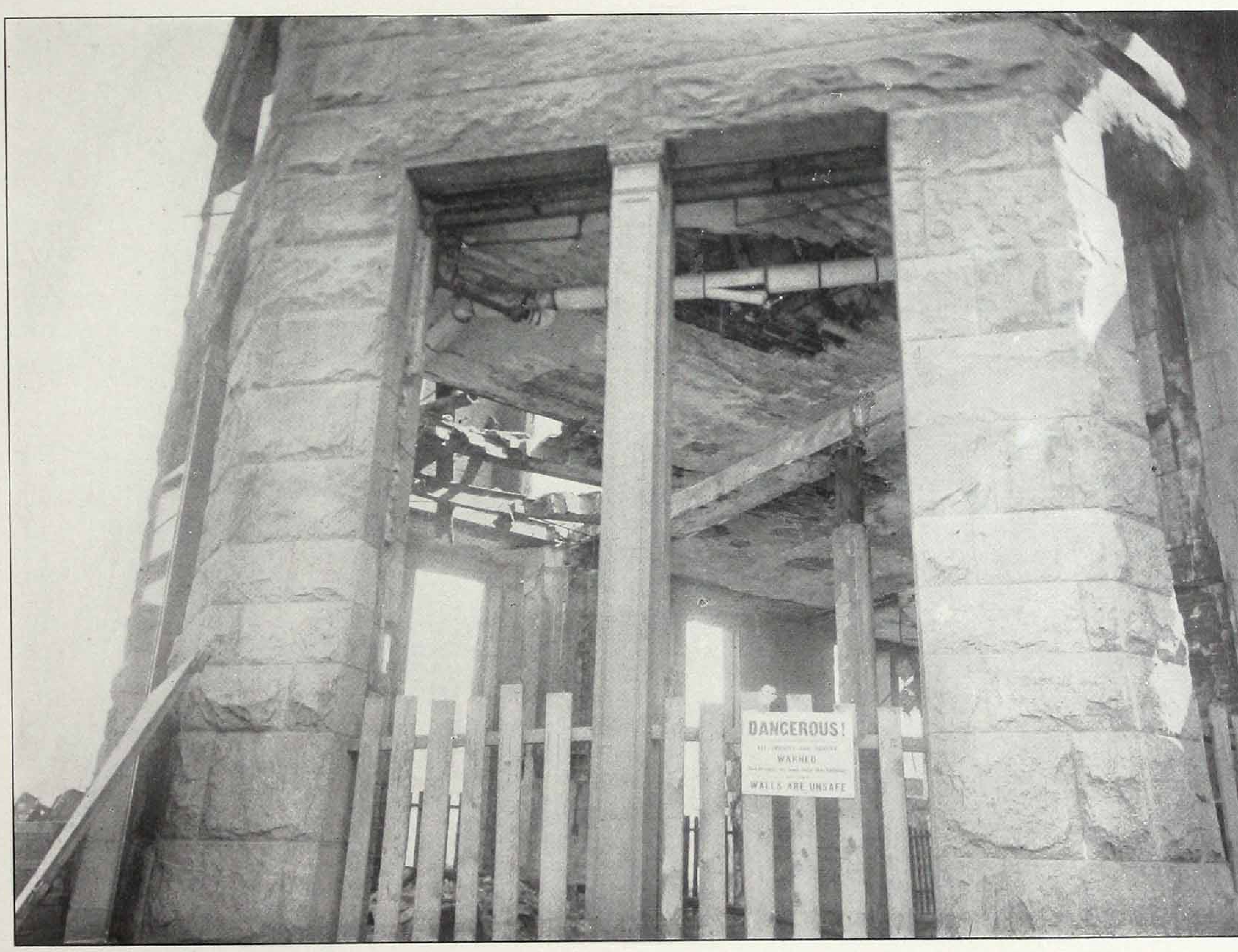
J. R. Worcester.

Lessons from a Fire

A PERIODICAL published in Boston, known as the *Brickbuilder*, whose columns show it to be the champion of only one type of construction, has in a certain issue published a chapter in which it undertakes to point out lessons in a disastrous fire in Montreal. This effort is to indicate the efficiency of porous terra-cotta construction, and it also undertakes to prop up this class of construction with a reflection upon the use of metal lath and plaster. We have taken some pains to ascertain somewhat of the facts in the case.

The *Brickbuilder* says:

"The skew-backs and arches are intact, except where a large safe falling from above has broken a portion of one panel, and it is to be noted that the arch did not collapse, but the safe remains where it fell on top of the arch. The arches and skew-backs have sustained no practical damage, retaining true and level as



when they were built, despite the fact that tons of debris, in the shape of broken cast-iron columns, twisted and broken girders, bricks, mortar, sheet iron, etc., fell in and is now deposited on them.

"The metal lath and plaster covering failed to afford any efficient protection to the lower flanges of the steel beams, the lathing having been stripped by the action of heat and water from the hangers, and in every case where this form of construction was used the lower flanges of the beams were apparently left unprotected at an early stage of the fire. The beams are twisted, the arches have sagged, and this portion of the work is practically a total loss. When one views these two forms of arches, side by side, there can be no question of the superiority of porous terra-cotta over metal lathing and plaster as a protection from fire."

The most important building involved in the fire was the Board of Trade building. In the construction of this no general system or scheme of fireproofing was followed. The buildings consisted of a central section

with two extending wings. Although this structure was five stories in height, the only fireproofing employed was the first floor of the main building and part of one of the wings. The upper floors were for the most part erected of iron girders supported by cast-iron columns, the floors, however, being of wood. That portion of the wings having wood floors and wood joists was totally destroyed. The Boston paper would have it appear that the failure of the terra-cotta blocks was due to weakness of lath and plaster of beam flanges. We present, on the preceding page, a photograph taken from the underside of the only floor where the terra-cotta was used. It will only take half an eye to see large holes through the terra-cotta between the beam lines. The girder or beam projecting, as shown in the engraving, was protected by metal lath and plaster. As will be seen this is intact. In other words, it was not damaged by the fire sufficiently to loosen it from its place. In some places not shown in the picture the metal lath had been fastened directly to the terra-cotta tiles. In these latter instances the lathing was torn away. There was no concrete used in the structure at all, except that there was possibly a very little bit of cement used in bonding together the rubbish material which was used as a filler on top of the tiling. We will leave the engraving to tell the balance of the story.